# Learning objectives

- Definition of joint
- Classification of joints
- General features of synovial joint
- Hilton’s laws
- Bursa
- Clinical case with anatomical explanation

# JOINTS

- regions of the skeleton where two or more bones meet and articulate.
- supported by a variety of soft tissue structures
- prime functions : facilitate growth or to transmit forces between bones, thereby enabling movement or weight to be transferred.

# Joints and Their Classification

- Arthrology = study of the joints
- Kinesiology = study of musculoskeletal movement

- Classified by freedom of movement (functional)
  - diarthrosis (freely movable)
  - amphiarthrosis (slightly movable)
  - synarthrosis (little or no movement)

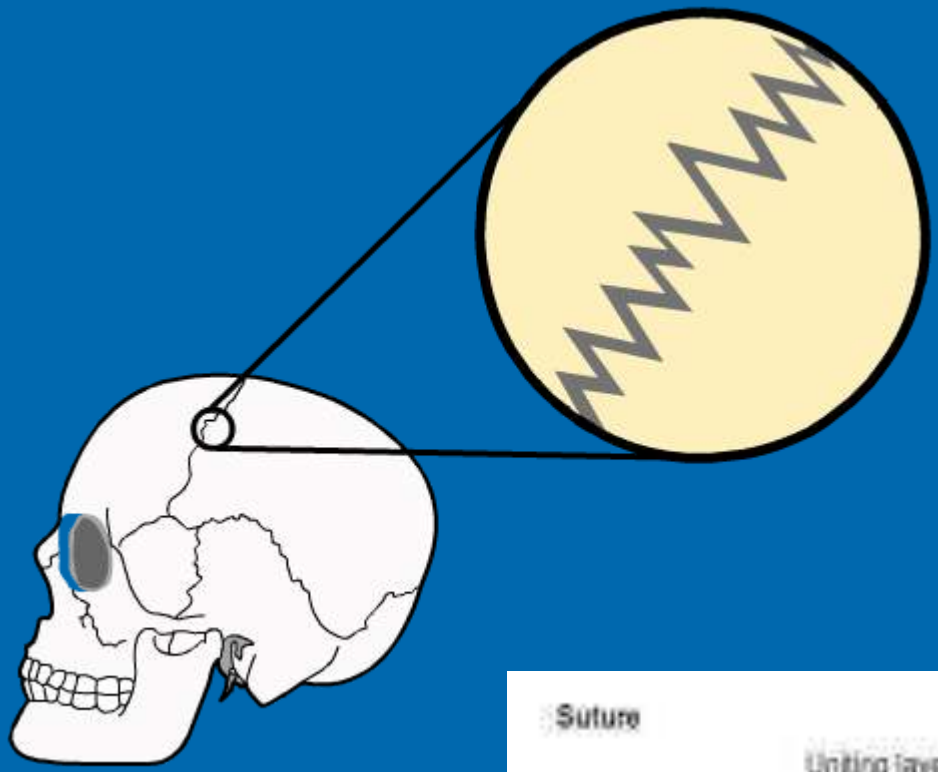
- Classified how adjacent bones are joined (structural)
  - Fibrous
  - Cartilaginous
  - Synovial

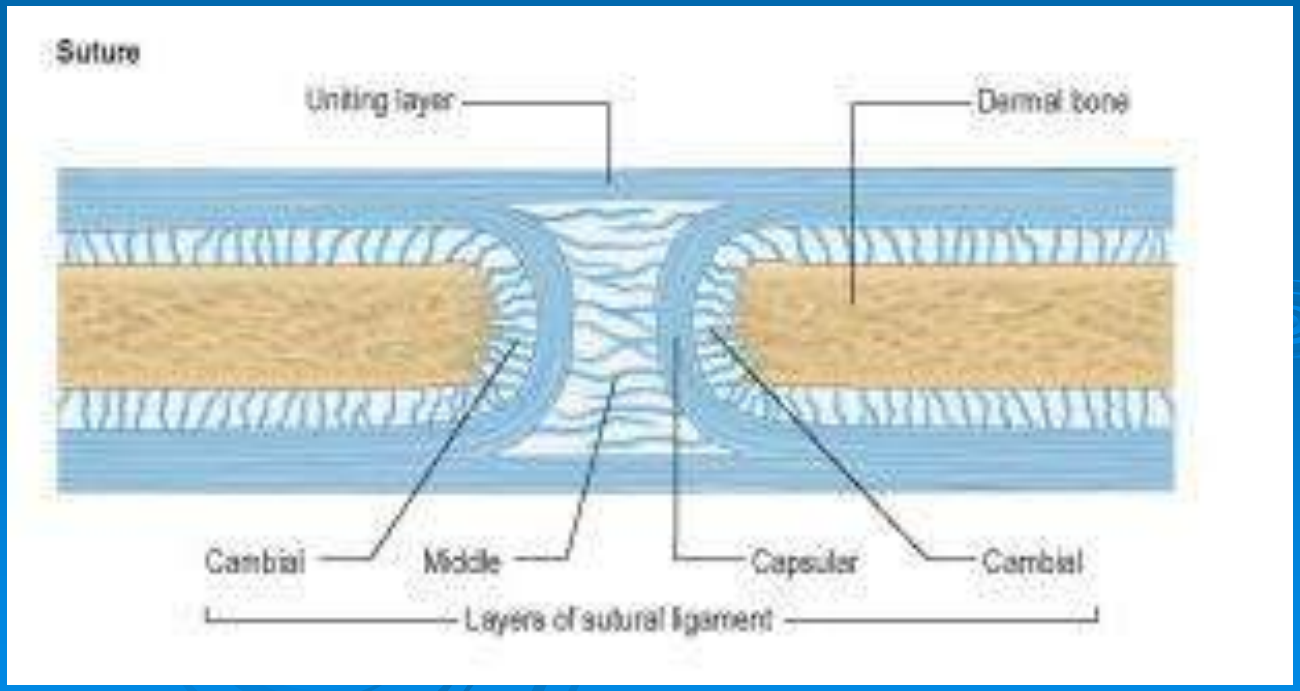
# Fibrous Joints (Synarthrosis)

- The bones forming the joint are united by fibrous connective tissue. These are either immovable or permit only slight degree of movement..
  - Sutures
  - Gomphoses and
  - Syndesmoses

# Fibrous Joint -- Sutures

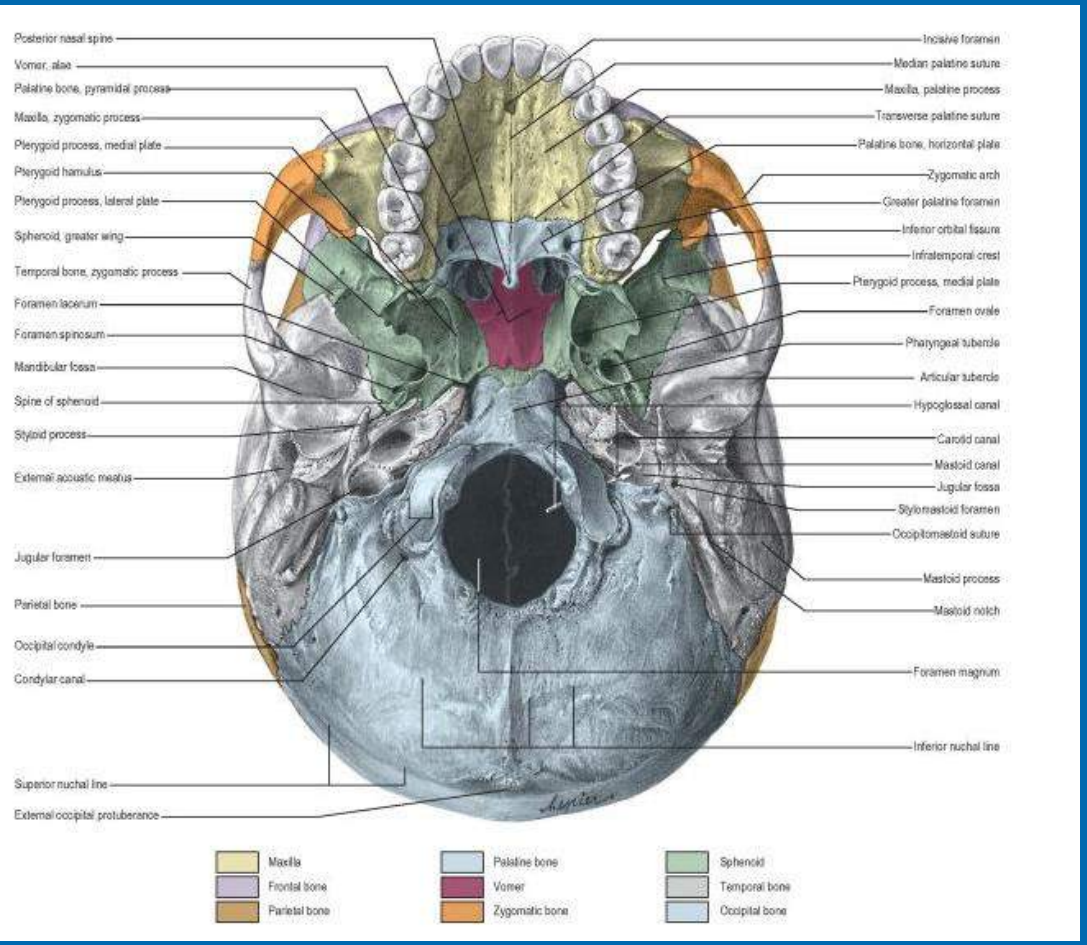
- Cranial and facial bones
- In a suture, the two bones are separated by a layer of membrane-derived connective tissue.
- This  connective tissue decreases with age so that the osteogenic surfaces become apposed.
- On completion of growth, many sutures synostose and are obliterated.

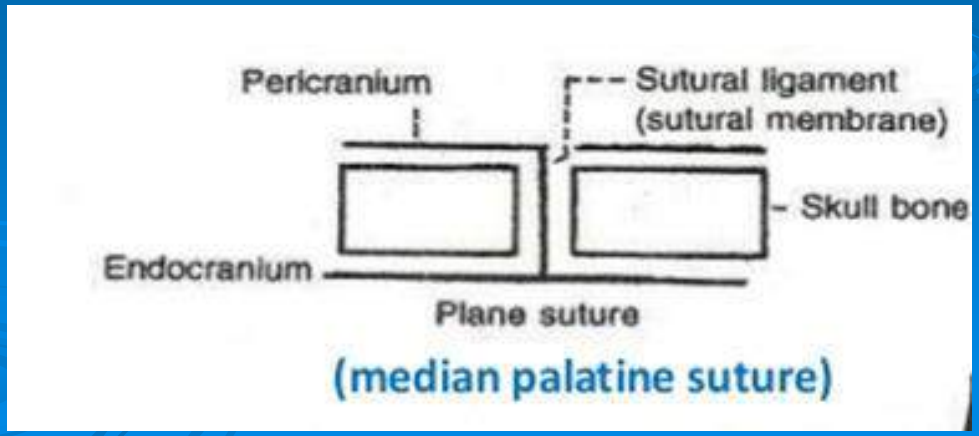


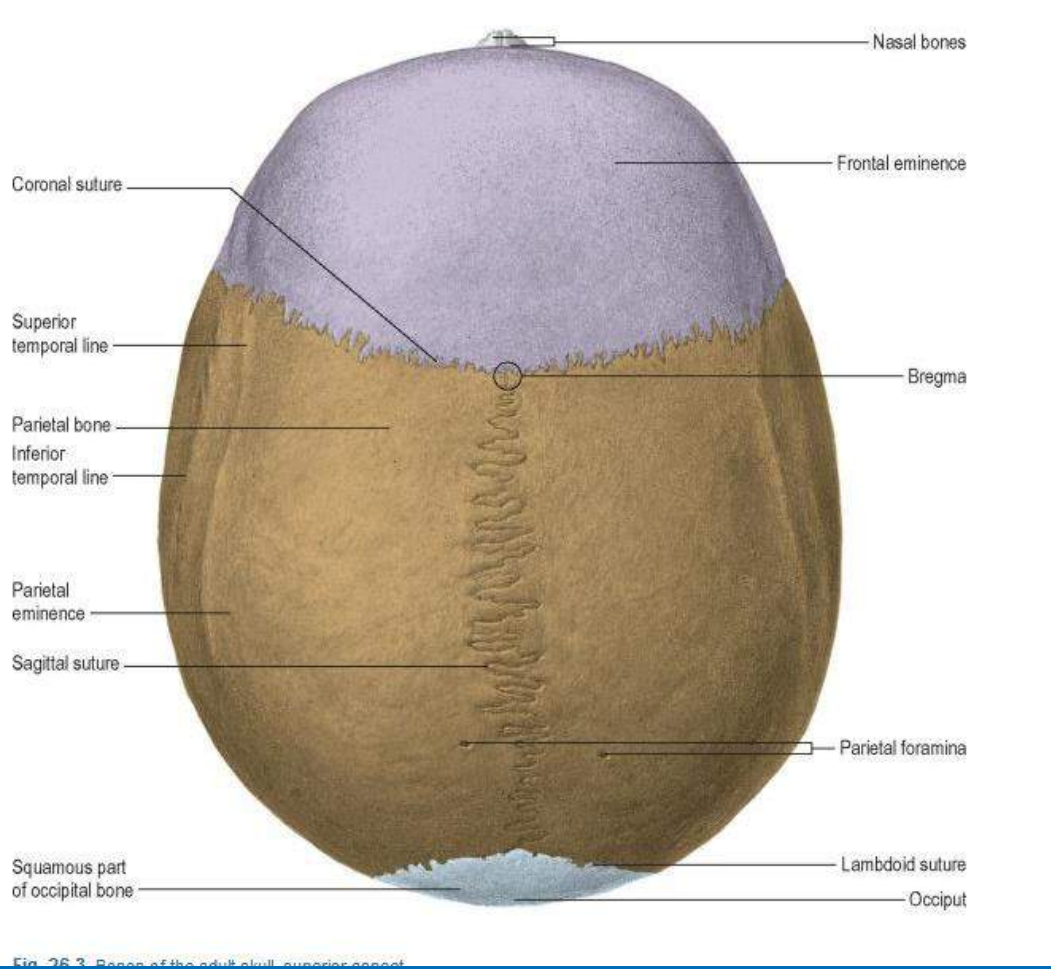

Suture
Uniting layer
Dermal bone
Cambial
Middle
Capsular
Cambial
Layers of sutural ligament

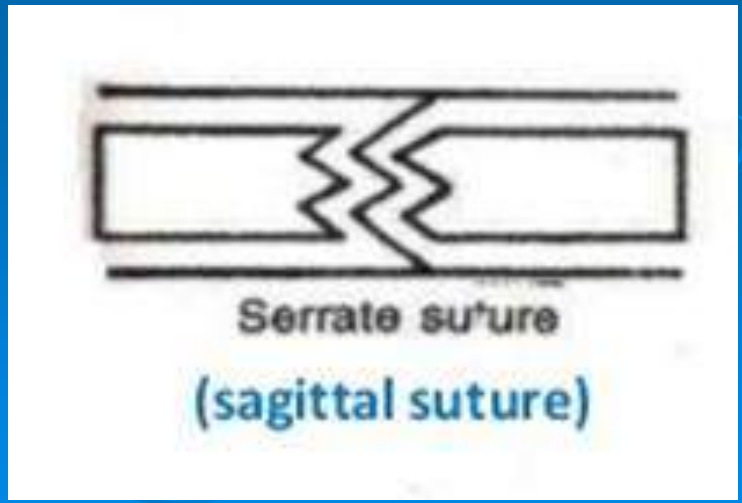
# Types of Sutures

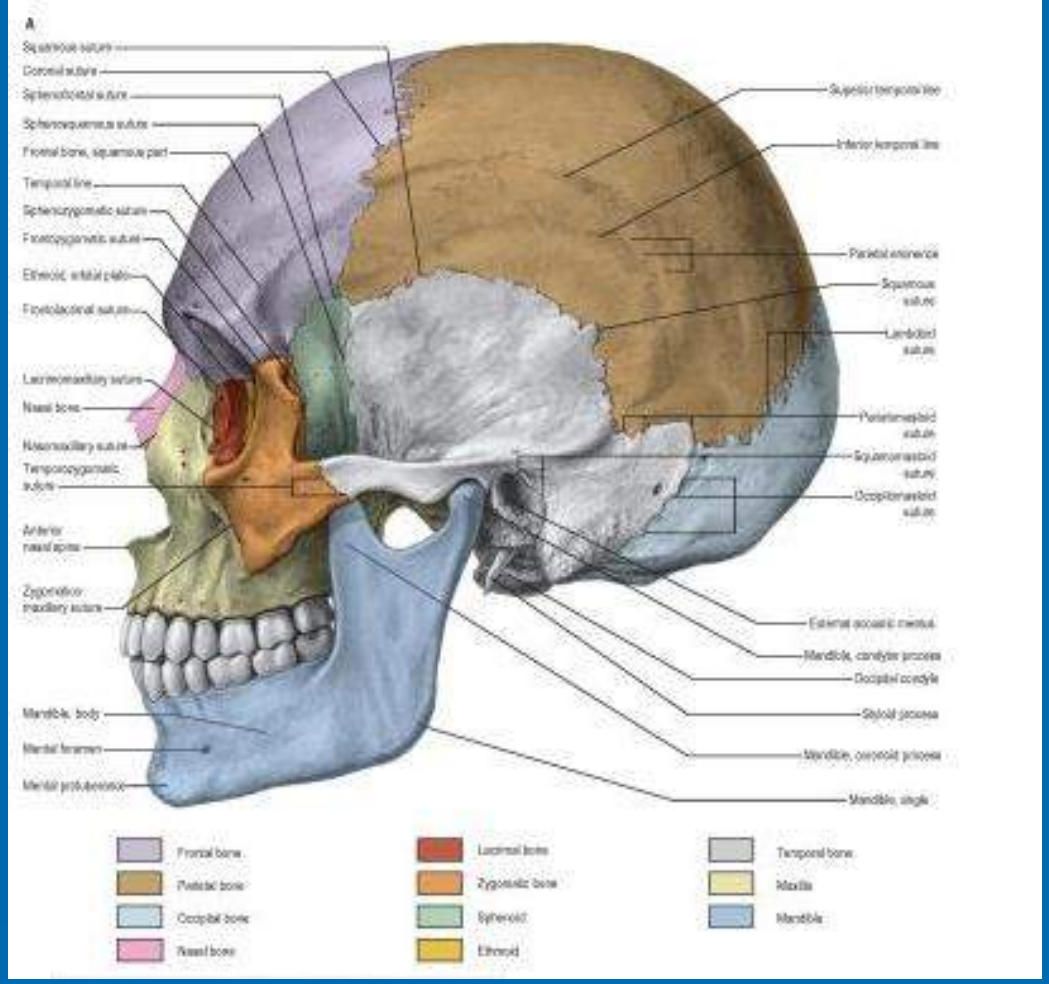
- Plane
- Serrate
- Denticulate
- Squamous
- Schindylesis


Posterior nasal spine
Vomer, alae
Palatine bone, pyramidal process
Maxilla, zygomatic process
Pterygoid process, medial plate
Pterygoid hamulus
Pterygoid process, lateral plate
Sphenoid, greater wing
Temporal bone, zygomatic process
Foramen lacerum
Foramen spinosum
Mandibular fossa
Spine of sphenoid
Styloid process
External acoustic meatus
Jugular foramen
Parietal bone
Occipital condyle
Condylar canal
Superior nuchal line
External occipital protuberance
Incisive foramen
Median palatine suture
Maxilla, palatine process
Transverse palatine suture
Palatine bone, horizontal plate
Zygomatic arch
Greater palatine foramen
Inferior orbital fissure
Infratemporal crest
Pterygoid process, medial plate
Foramen ovale
Pharyngeal tubercle
Articular tubercle
Hypoglossal canal
Carotid canal
Mastoid canal
Jugular fossa
Stylomastoid foramen
Occipitomastoid suture
Mastoid process
Mastoid notch
Foramen magnum
Inferior nuchal line
Maxilla
Frontal bone
Parietal bone
Palatine bone
Vomer
Zygomatic bone
Sphenoid
Temporal bone
Occipital bone


Pericranium
Sutural ligament
(sutural membrane)
Skull bone
Endocranium
Plane suture
(median palatine suture)

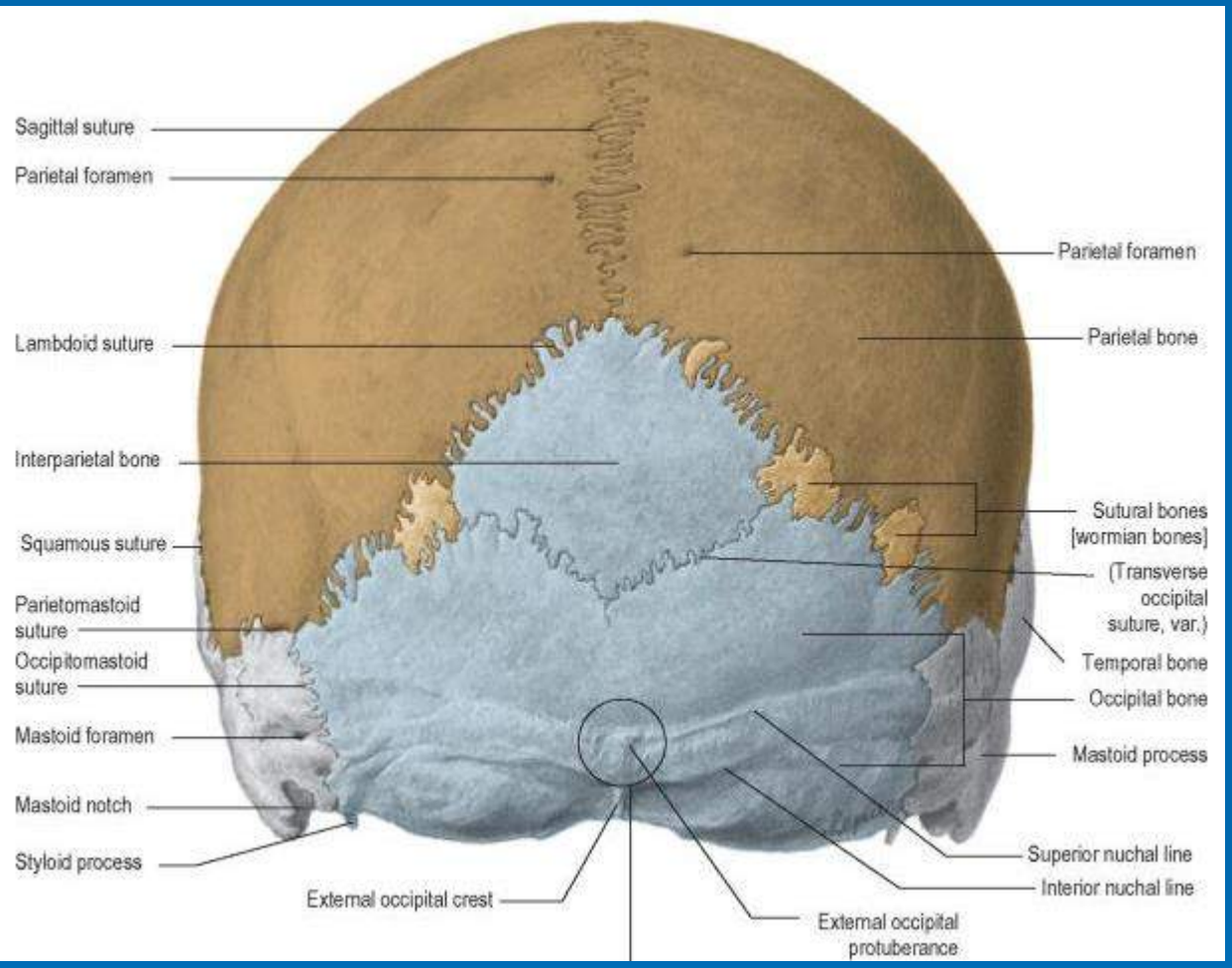

Nasal bones
Frontal eminence
Coronal suture
Superior temporal line
Bregma
Parietal bone
Inferior temporal line
Parietal eminence
Sagittal suture
Parietal foramina
Squamous part of occipital bone
Lambdoid suture
Occiput


Serrate suture
(sagittal suture)




Squamous suture

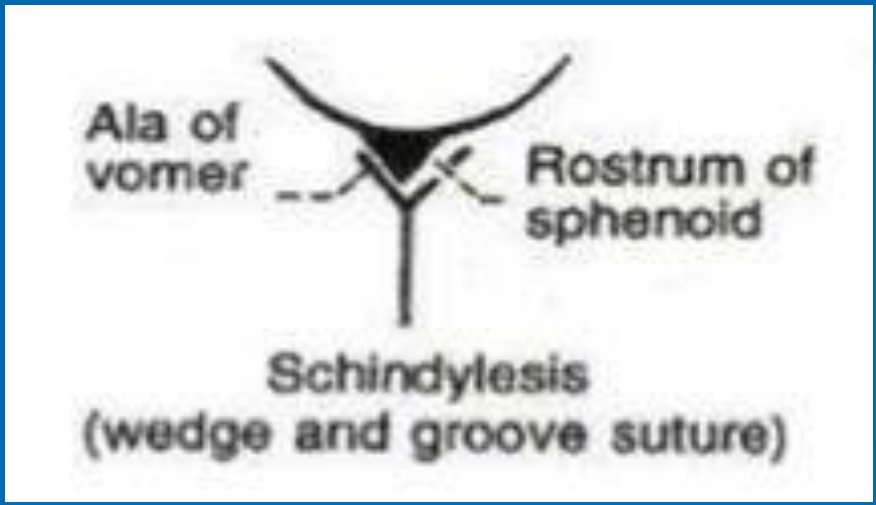
(between temporal & parietal bone)




Denticulate suture

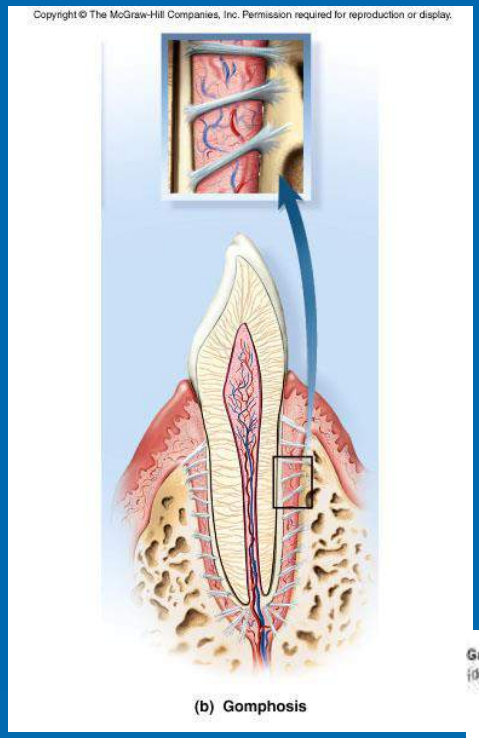
(lambdoid suture)

# Schindylesis



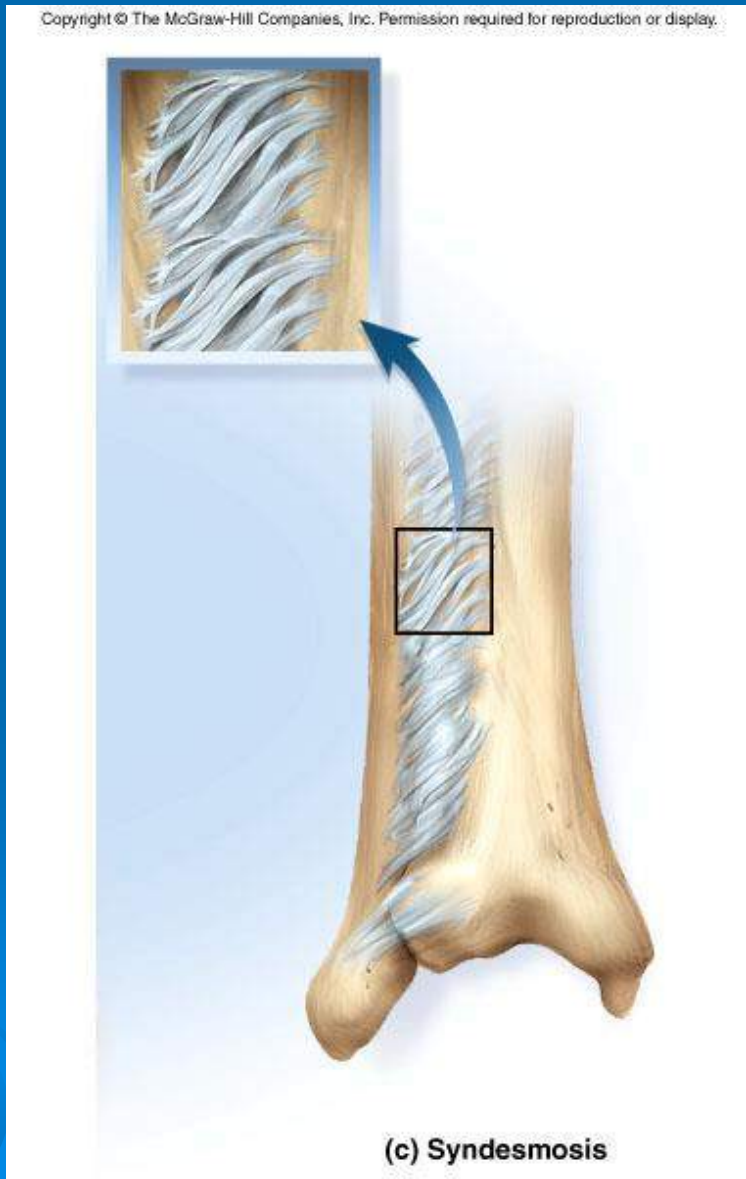
# Fibrous Joint -- Gomphoses

- Attachment of a tooth to its socket
- Held in place by fibrous periodontal ligament
  - collagen fibers attach tooth to jawbone
- Some movement while chewing



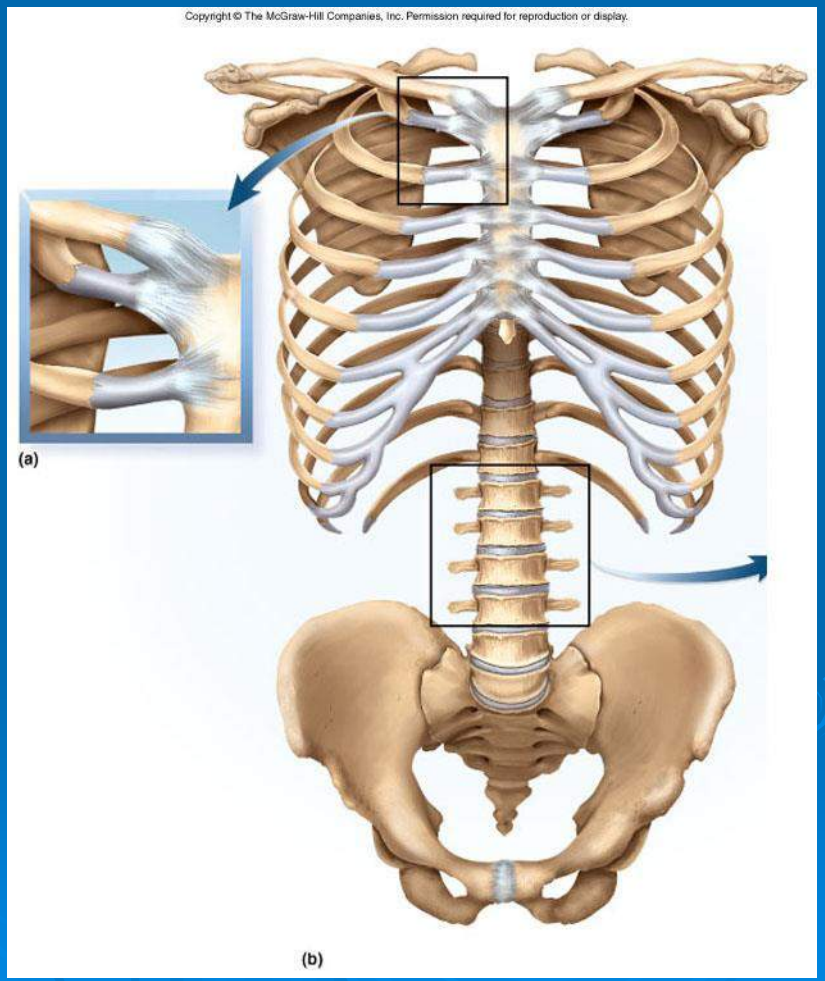

# Fibrous Joint -- Syndesmosis

- Two bones bound by CT called the interosseus membrane.
- Most movable of fibrous joints
- Interosseus membranes unite radius to ulna and tibia to fibula



# Cartilaginous Joint – Primary cartilaginous joints (Synchondrosis)

- Bones are joined by hyaline cartilage
  - 1st rib attachment to sternum
  - epiphyseal plate in children binds epiphysis and diaphysis
  - Immovable
  - Synostoses occurs



# Cartilaginous Joint – secondary cartilaginous joints (Symphysis)

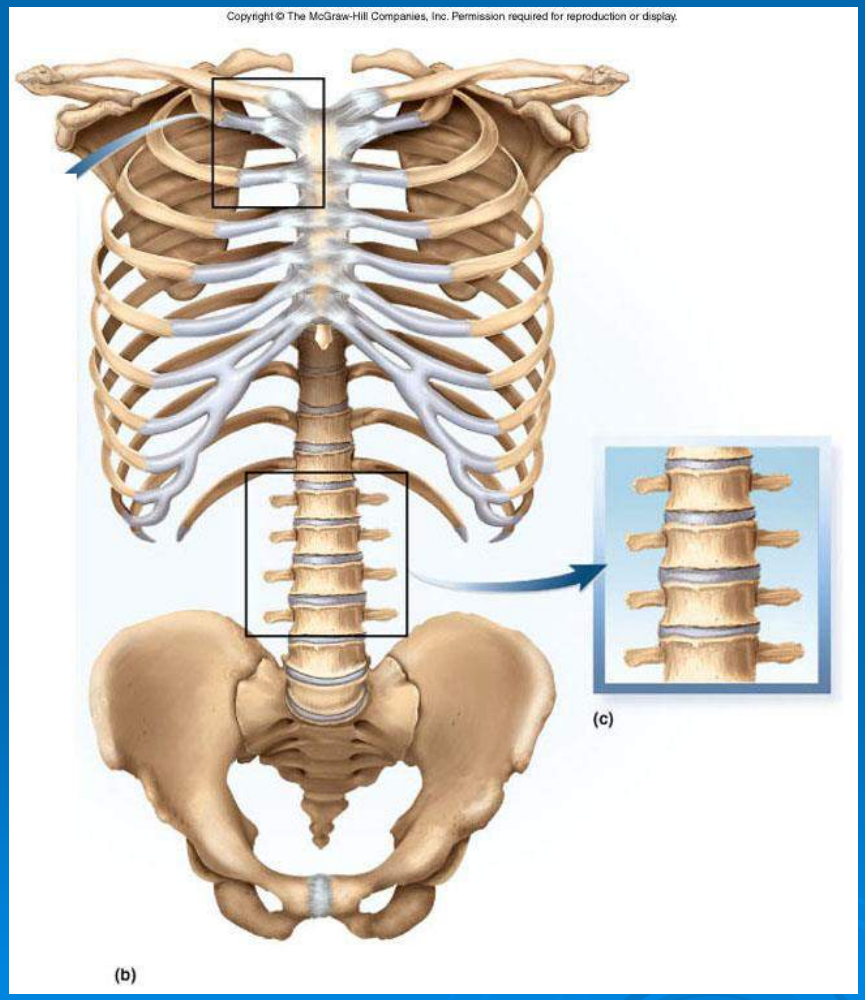
- They are defined by the presence of an intervening pad or disc of fibrocartilage interposed between the articular hyaline cartilage that covers the ends of two bones

  a)pubic symphysis and

  b)intervertebral discs (between body of vertebra)

- Only slight amount of movement is possible
- Mostly all  midline joints are symphysis except symphysis menti

# symphysis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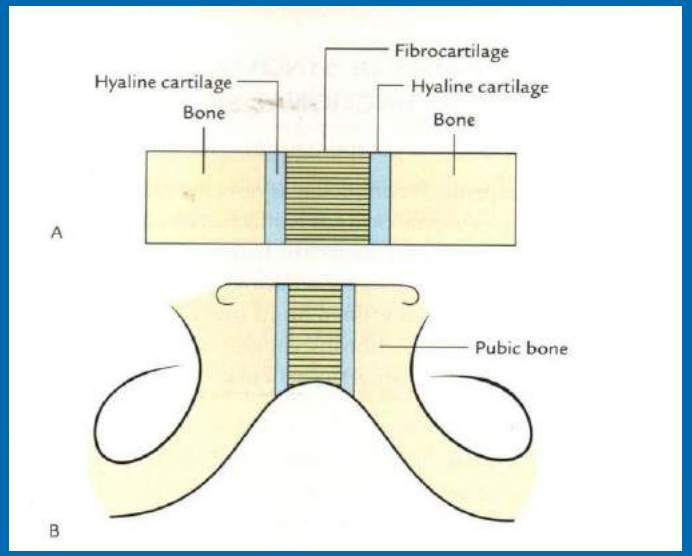
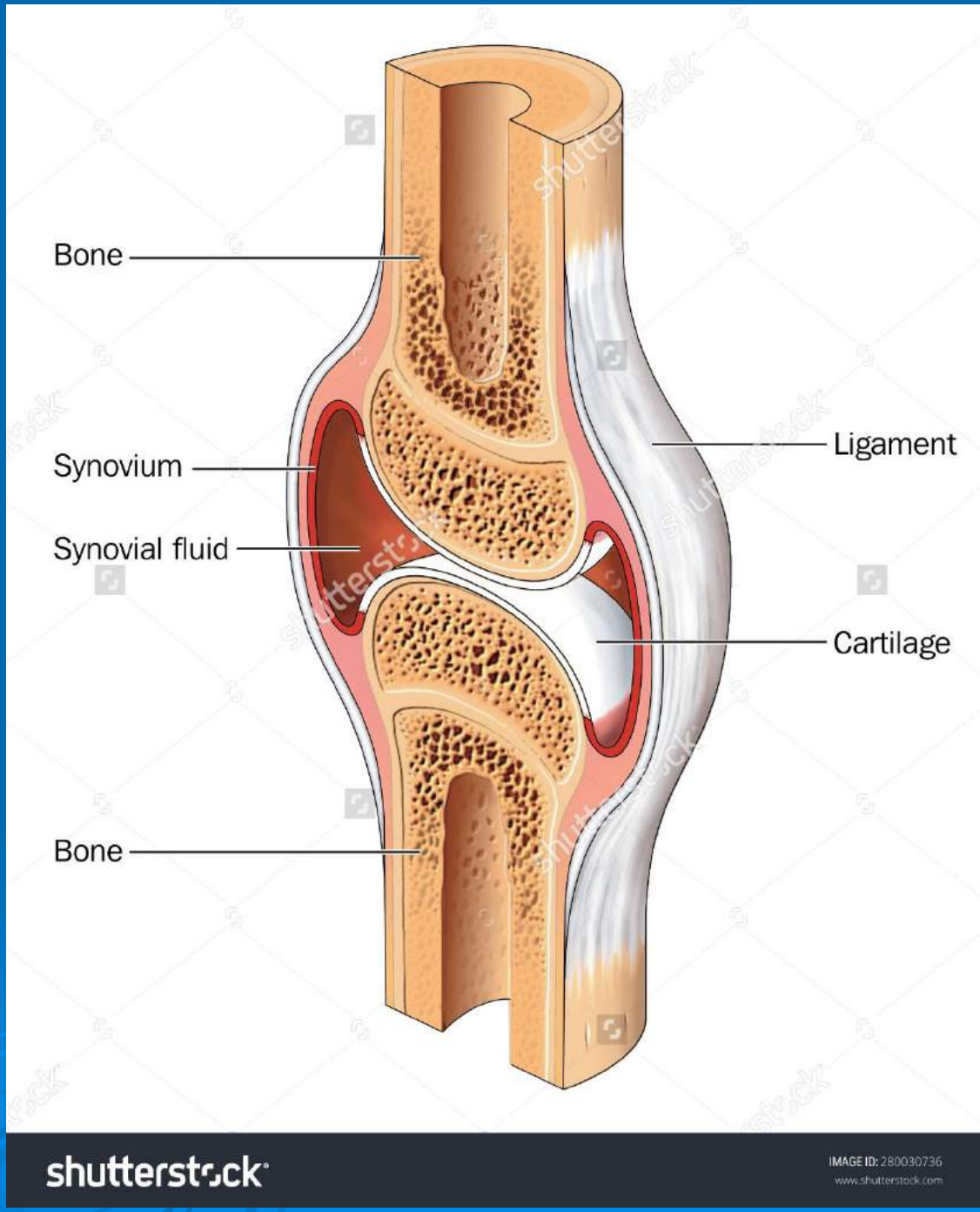
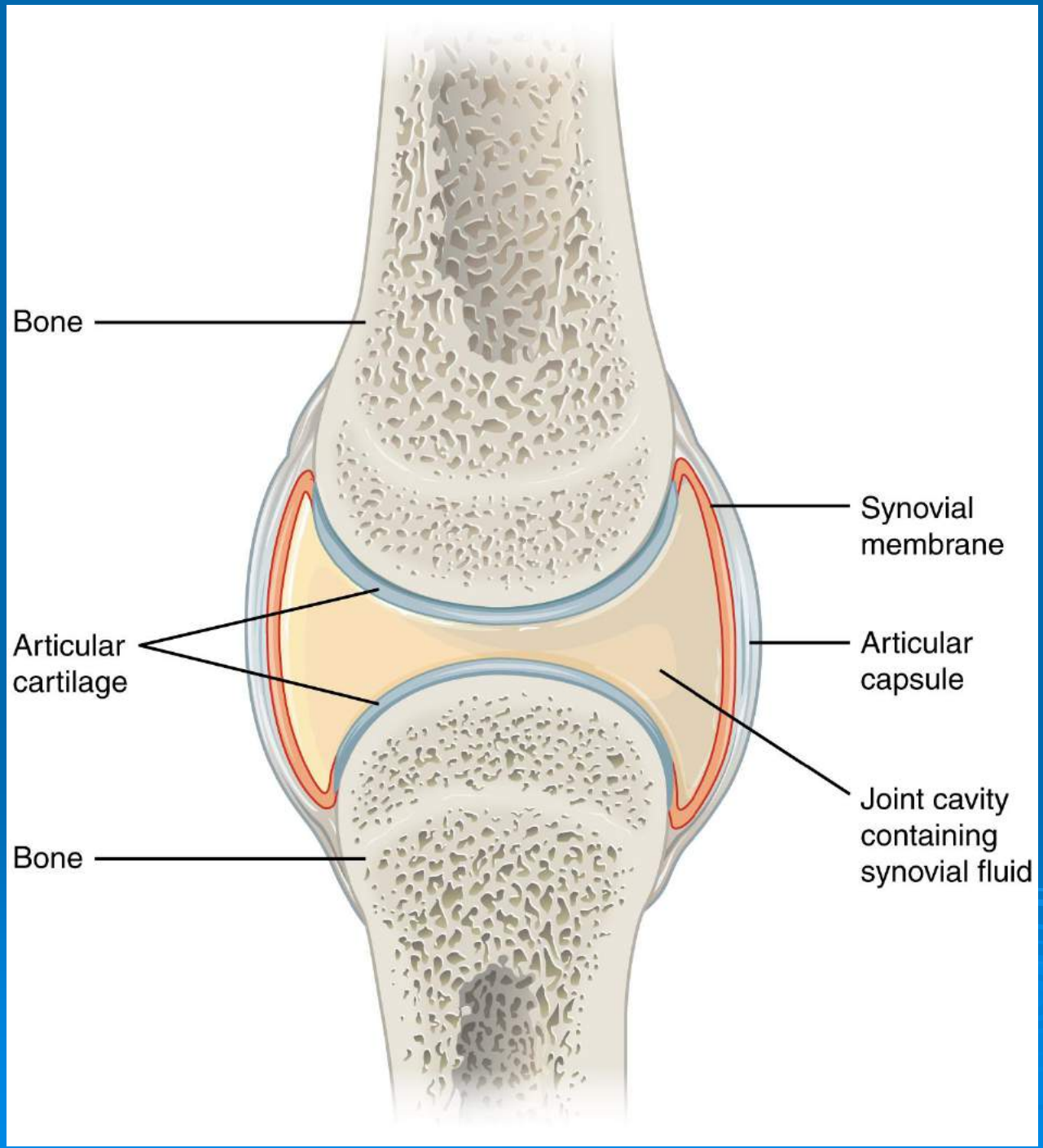
(b)
(c)


Fibrocartilage
Hyaline cartilage
Hyaline cartilage
Bone
Bone
A
Pubic bone
B

# Synovial Joint




Bone
Articular cartilage
Bone
Synovial membrane
Articular capsule
Joint cavity containing synovial fluid

# Components Of Synovial Joints And Their Functional Significance

1. FIBROUS CAPSULE

invests the joint like a sleeve and encloses synovial cavity (except where there are synovial protusions)

Function :

a) stabilizes the joint in such a way that it permits movements but resists dislocation.

b) numerous sensory nerve endings ramify on the capsule. The stimulation of the nerves produce reflex contraction of muscle acting on the joint.

2. SYNOVIAL MEMBRANE :

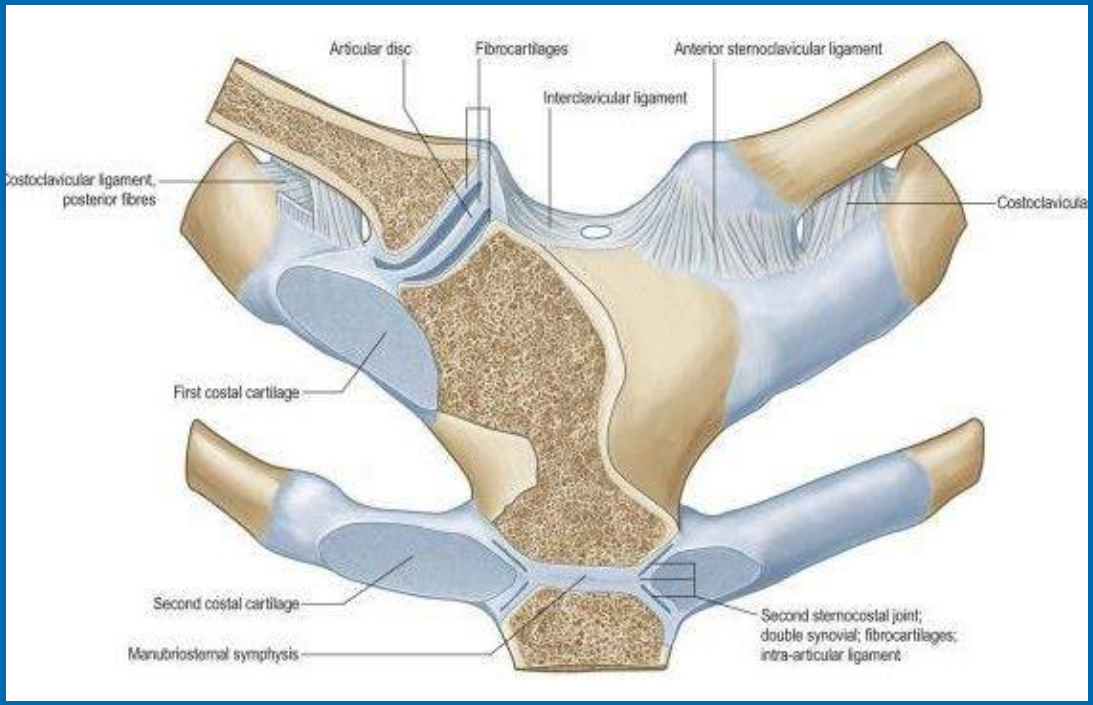
- It is a thin vascular membrane of connective tissue lining inside of the fibrous capsule.
- The articular cartilages are not covered by it.
- Also absent from intra-articular discs and menisci
- FUNCTION: produces synovial fluid in sufficient quantity to keep the surface lubricated.

3. ARTICULAR CARTILAGE: hyaline cartilage covering the joint surfaces mostly . It provides smooth friction free movements and resists compression forces.

4.ARTICULAR DISCS AND MENISCI: these are pads of fibrocartilage interposed between the articular surface of some joints eg. Jaw (temporomandibular joint) , wrist (radioulnar joint), sternoclavicular and knee joints

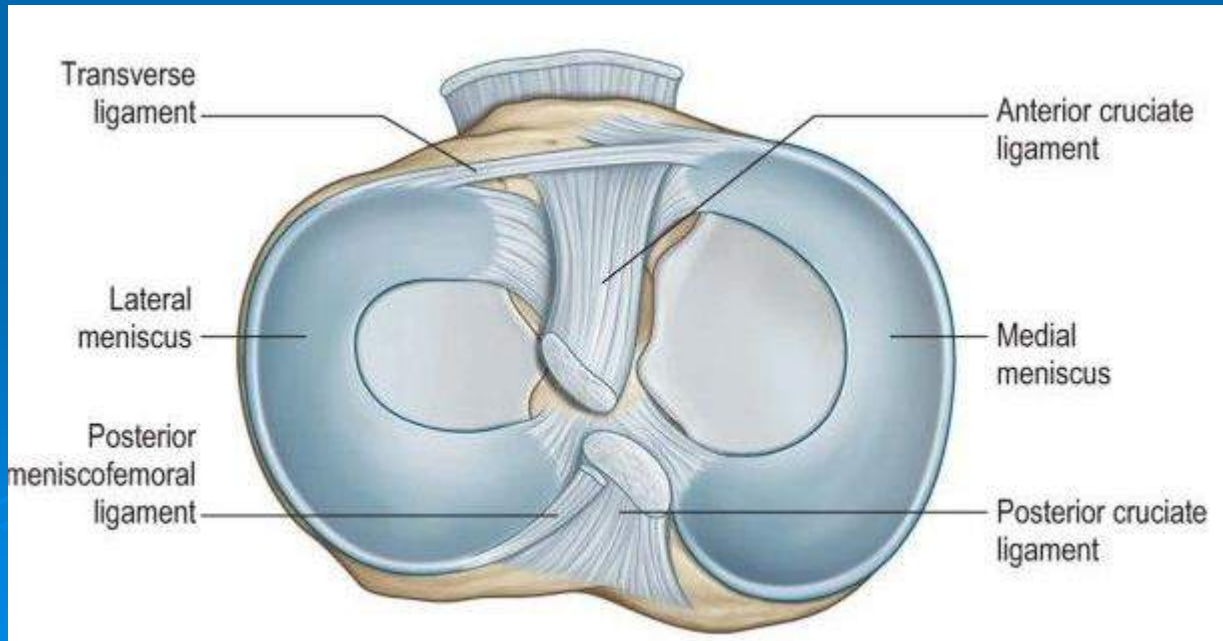
FUNCTION:

a) Helps in lubrication of joints by maintaining an interval between the articular surface.
b) Divides the joint into two compartments.
c) Prevents wear and tear of articular cartilage by providing a cushioning effect.




# Articular disc

# Menisci



5. . LIGAMENT : thickened band of connective tissue that attaches bone to bone

Two types:

a) True ligaments (intrinsic ligaments):

- local thickenings of fiber bundles of the capsule,
- Stabilize the joint and permit movement in one plane. Eg. Medial and lateral collateral ligaments.

b) Accessory ligaments: these are separate from the fibrous capsule. Stabilizes the joint and limits the range of movements

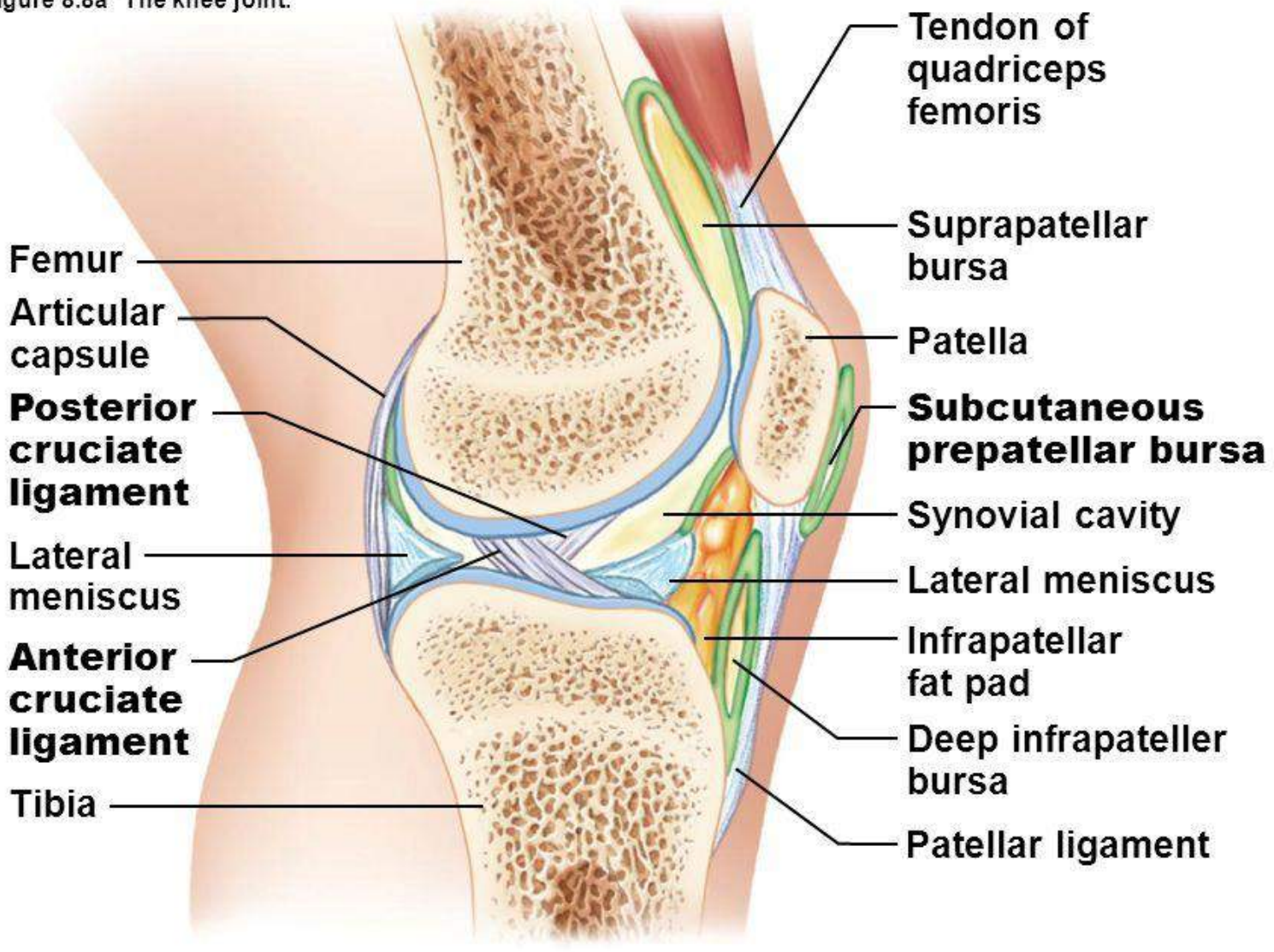
Two types

i) Extracapsular: stylomandibular and sphenomandibular

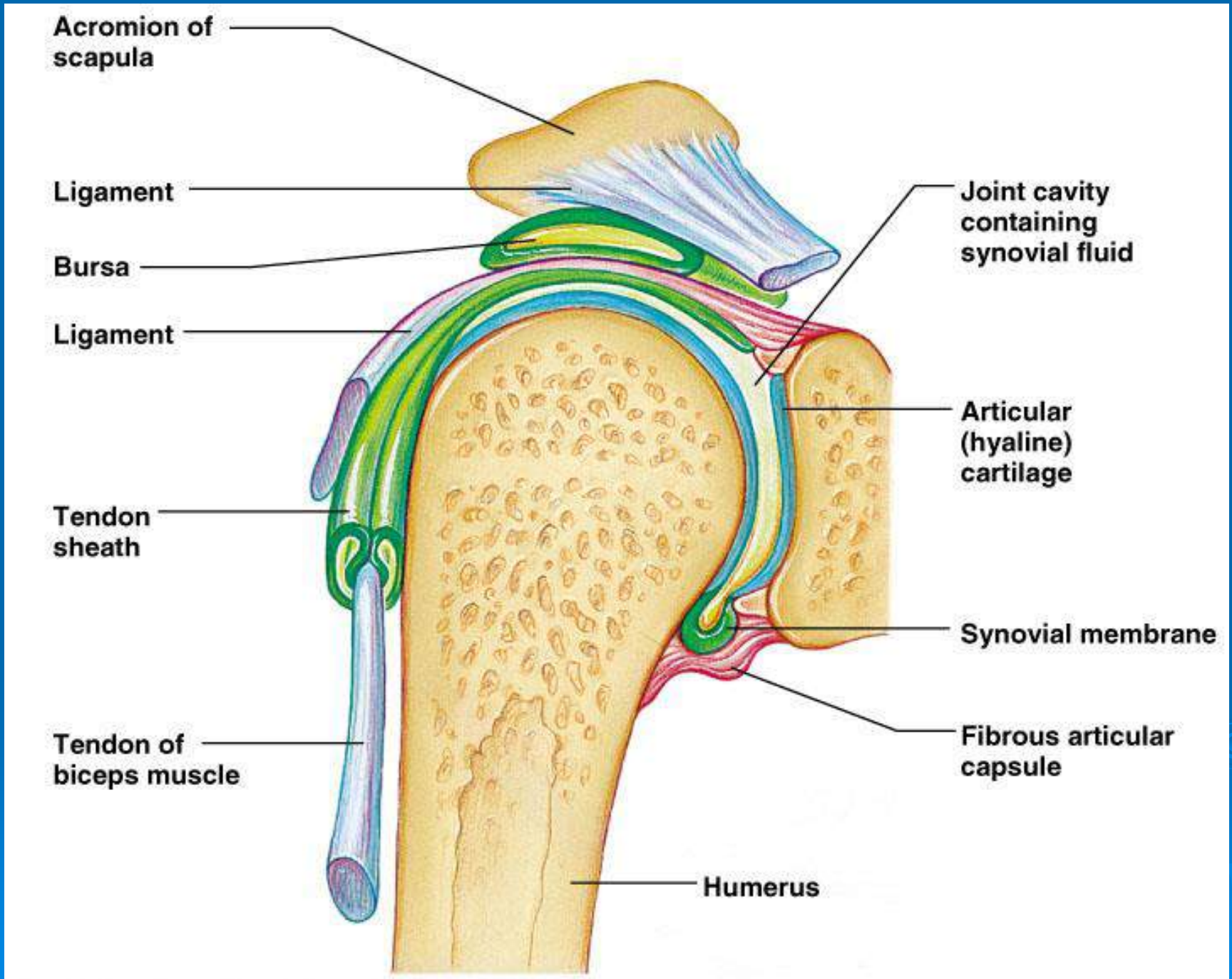
ii) Intracapsular. Cruciate ligaments of knee joint

6. Bursa (synovial flexor sheaths)
7. Fat Pads
8. Tendon

Figure 8.8a The knee joint.




(a) Sagittal section through the right knee joint



# CLINICAL CORRELATION: osteoarthritis

Blood supply of synovial joint: from the periarticular network of arteries that surround the joint. Supplies capsule, synovial membrane and epiphysis.

(articular cartilages are avascular)

Nerve supply of synovial joint:

a) Sensory nerves conveying pain
b) Sensory nerves conveying proprioception.
c) Autonomic fibers which have vasomotor effects.

- HILTON'S LAW: it states that the nerves supplying the joint also supply the muscles regulating the movements of joint and skin over the joint.

- Segmental innervation of joints.

# Factors maintaining the stability of synovial joint

- BONES
- LIGAMENTS
- MUSCLES

Clinical correlation: Dislocation of joint

# CLASSIFICATION OF SYNOVIAL JOINTS

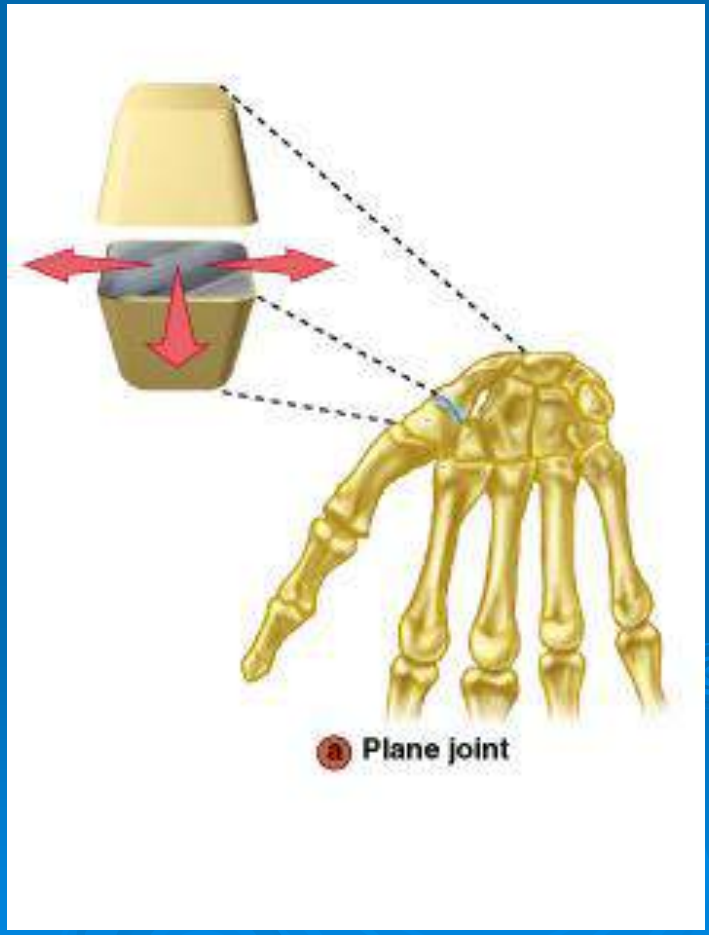
- Based on the shape of articulating surfaces
- According to plane/planes of movements
- According to number of articulating bones

# A. According to shapes of articulating surfaces

- Plane Joint
- Hinge Joint
- Pivot Joint
- Condyloid Joint
- Ellipsoid joint
- Saddle-shaped joint
- Ball and Socket Joint

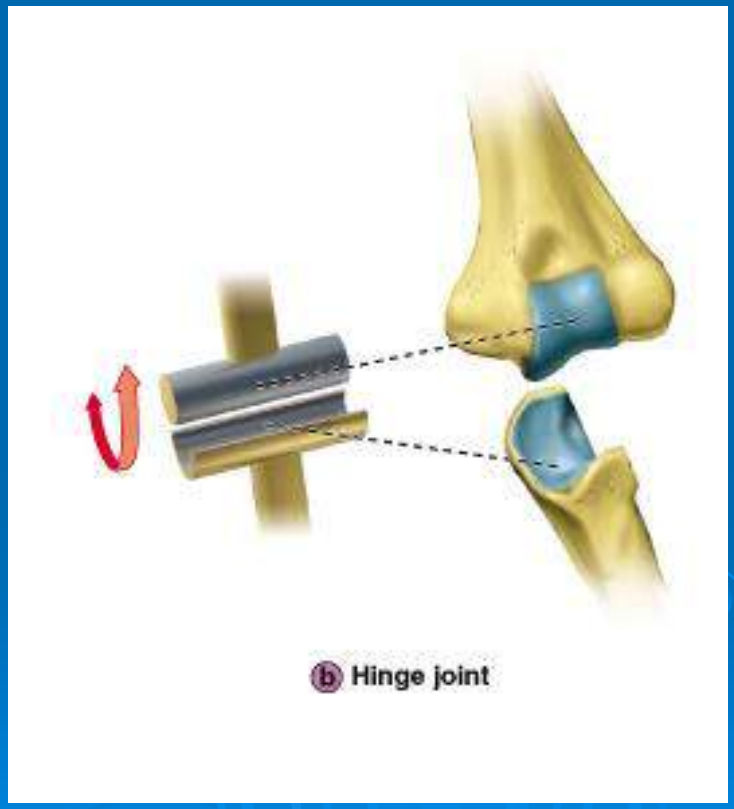
# Plane joints (gliding joints)

- Articular surfaces are nearly flat.
- Allow gliding movements.
- e.g. intercarpal and intertarsal joints.

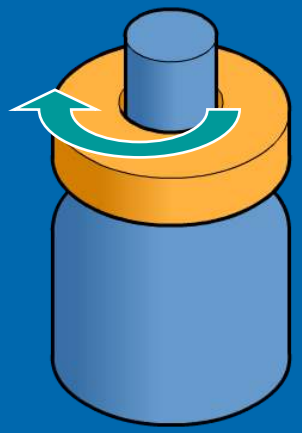


# Hinge joint (Ginglymus jt)

- Articular surfaces are pulley shaped.
- Movements are permitted only in one plane.
- Most common joints.
- e.g. elbow, ankle and interphalangeal joints



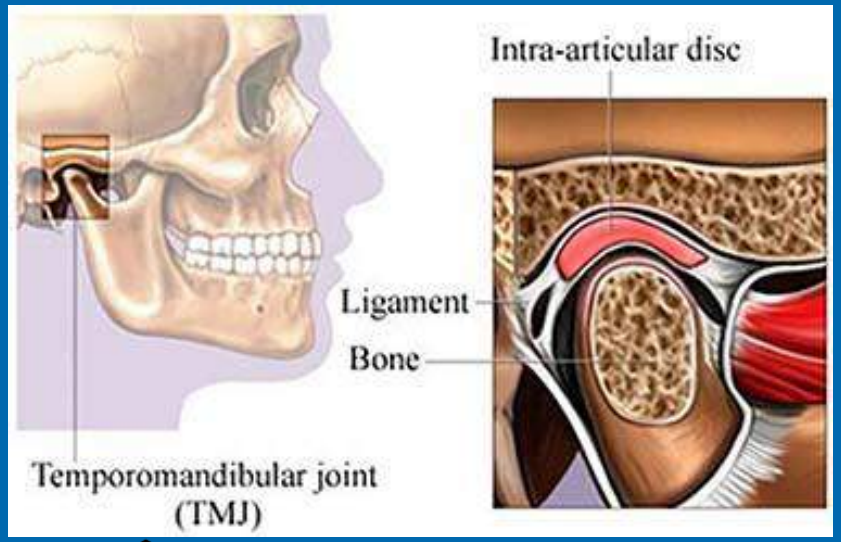
# Pivot joint

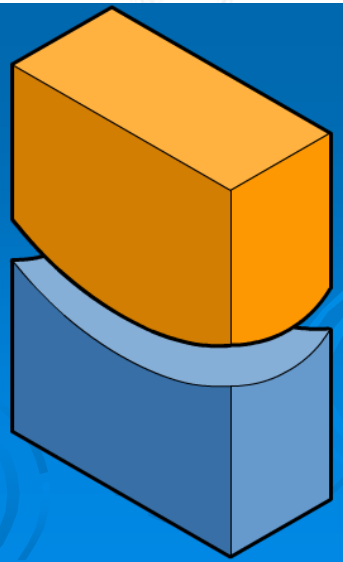


- Rounded end of one bone fits into the concavity of another bone.
- The rounded part surrounded by a ligament
- Limited rotation around the axis.
- e.g. superior radio-ulnar and median atlanto-axial joints.


# Condylar joints

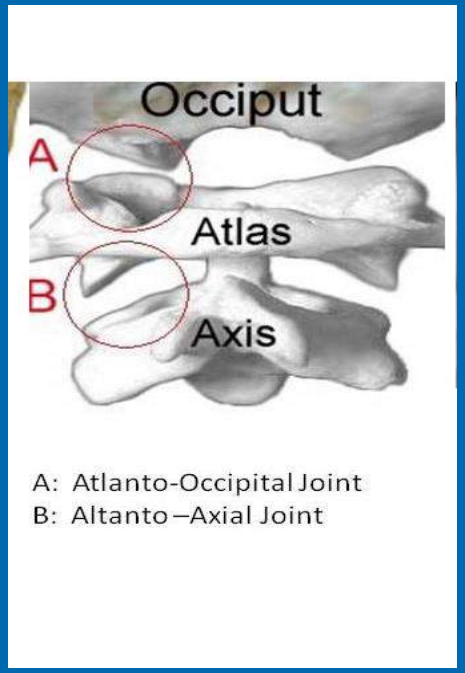
- An oval-shaped bone end which fits into a correspondingly shaped bone end..
- Permit movements in two directions.
- e.g.temporo-mandibular joints and knee joint

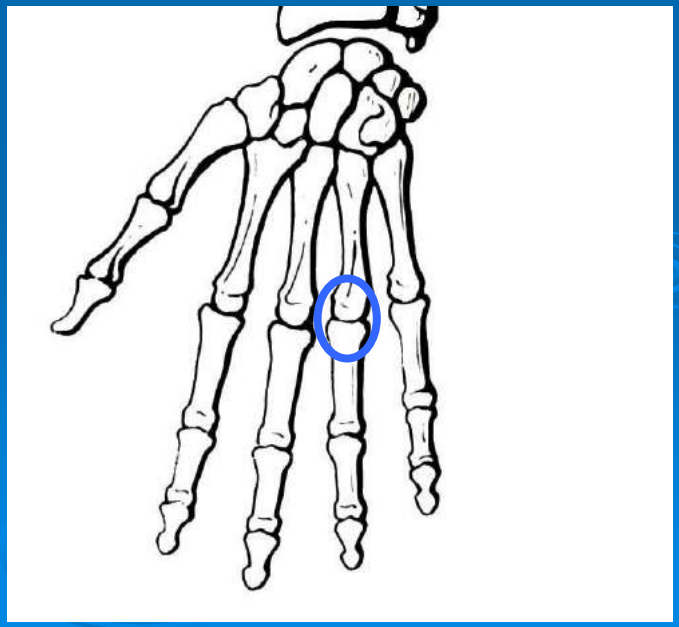


# Ellipsoid joint

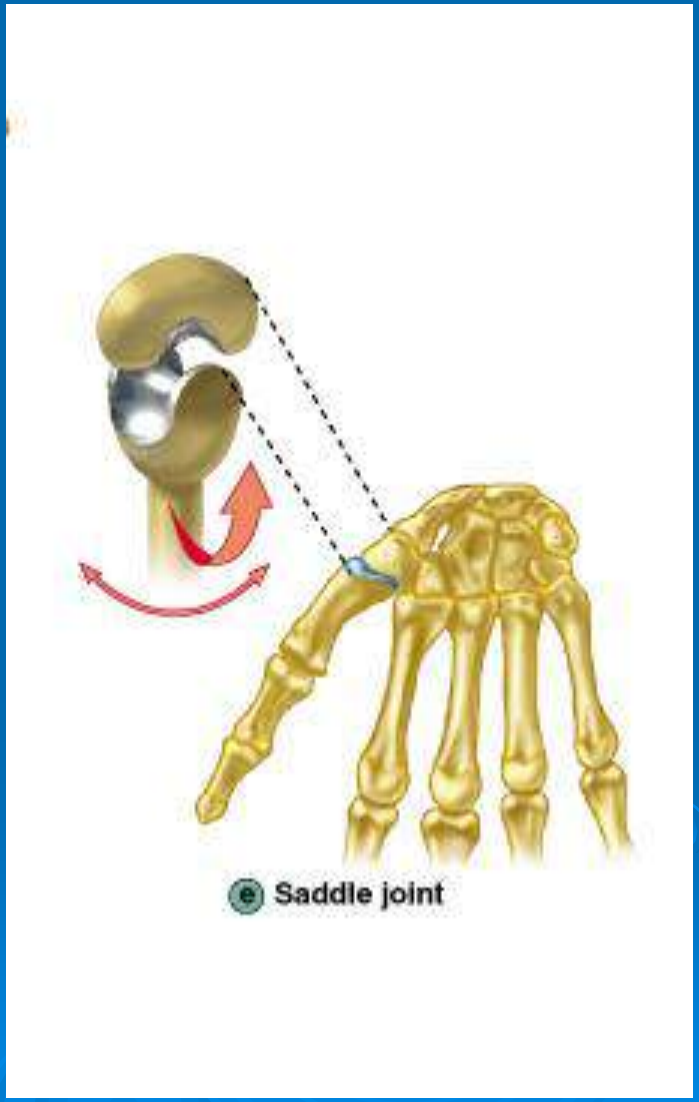
- Elliptical convex surface of one bone articulates with elliptical concave surface of another.
- Permit movements in two directions.
- e.g. wrist (radiocarpal), lat atlanto-occipital joint and metacarpophalangeal joint



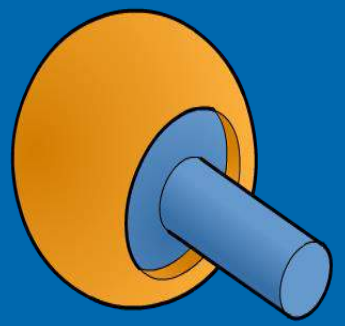



# Saddle joint (sellar )

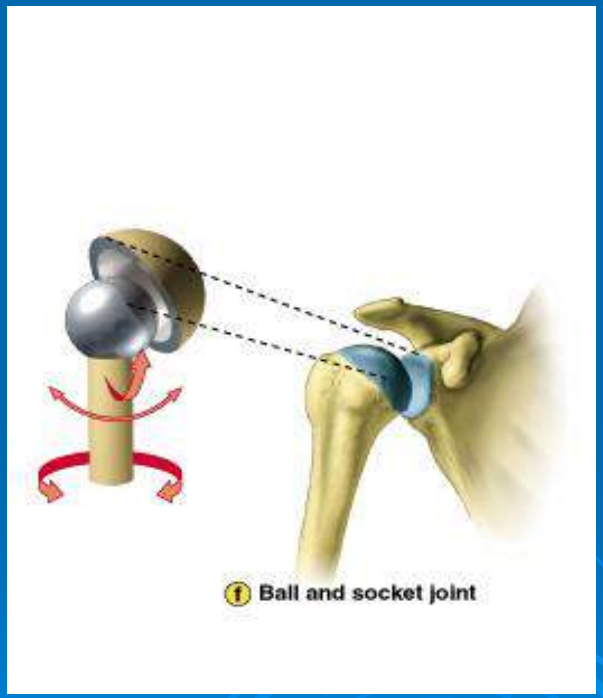
- Articular surfaces are reciprocally saddle shaped i.e. concavo-convex.
- Allows a wide range of movement.
- e.g. first carpo-metacarpal, sterno-clavicular, incudo-malleolar joints.



# Ball & socket (spheroidal)



- Rounded convex surface of one bone fits into the cup-like socket of another bone.
- Permits greatest range of movements.
- e.g. shoulder, hip and incudo-stapedial joints.



# B. According to the plane/ planes of movement

- Uniaxial: along one axis

1. Hinge joint :Movements only along transverse axis so only flexion and extension
2. Pivot joint: movement only along the vertical axis so only rotation.

- Biaxial: along two axis

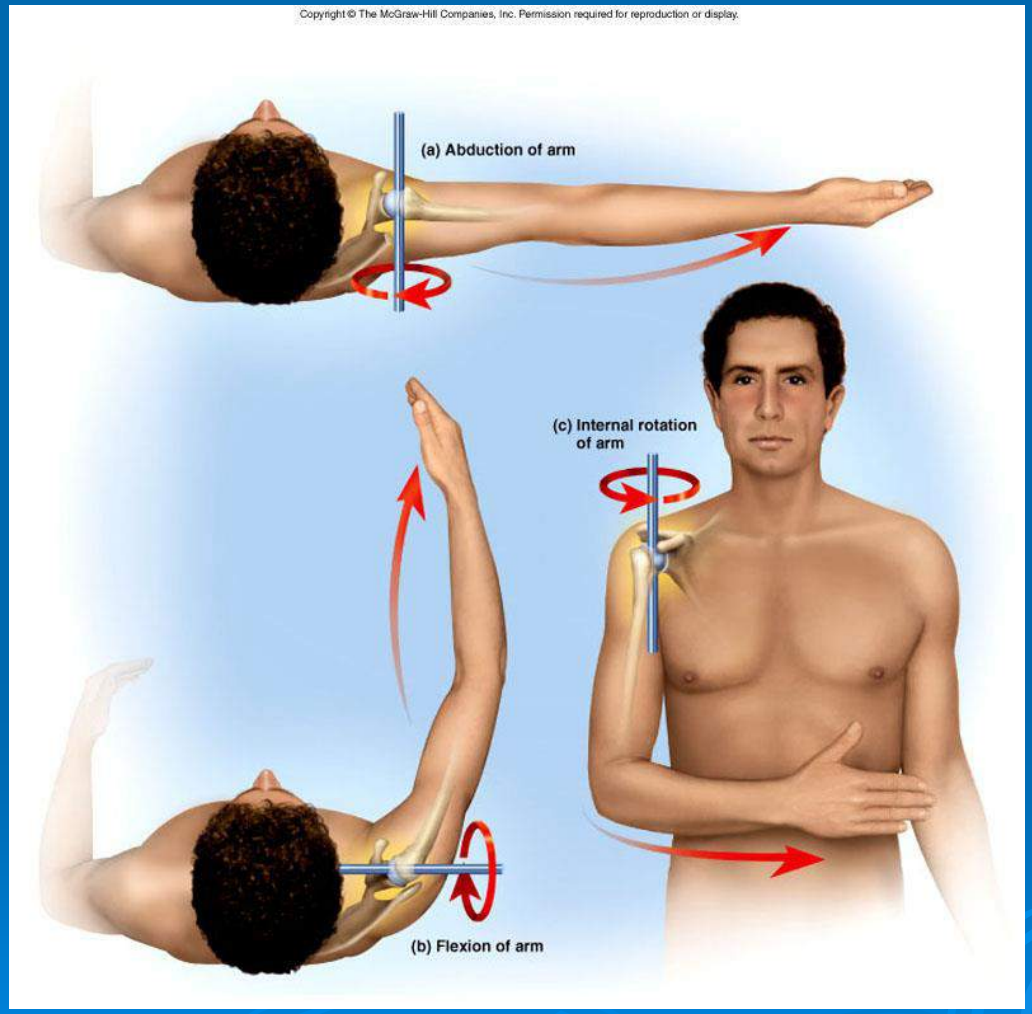
1. Condylar joint
2. Ellipsoid joint
3. Saddle joint

- Multiaxial: along many axis

Eg. Ball and socket

Movements occur in three planes or axis. So all kind of movements possible. circumduction

# Axis of Rotation




Shoulder joint has 3 degrees of freedom : multiaxial joint

# C. According to the number of articulating bones

- Simple joints: only two bones take part in formation of joint. Eg. Interphalangeal joints of fingers and toes.
- Compound joints: more than two bones take part in formation of joint.

a) Ankle joint: tibia , fibula and talus
b) Knee joint: femur, tibia and patella

# Movements of synovial joints

- Gliding or slipping
- Angular movements
- Rotary or circular movements

# Synovial joints – sporting examples

During the butterfly stroke, the ball and socket joint of the shoulder allows the swimmer's arm to rotate.

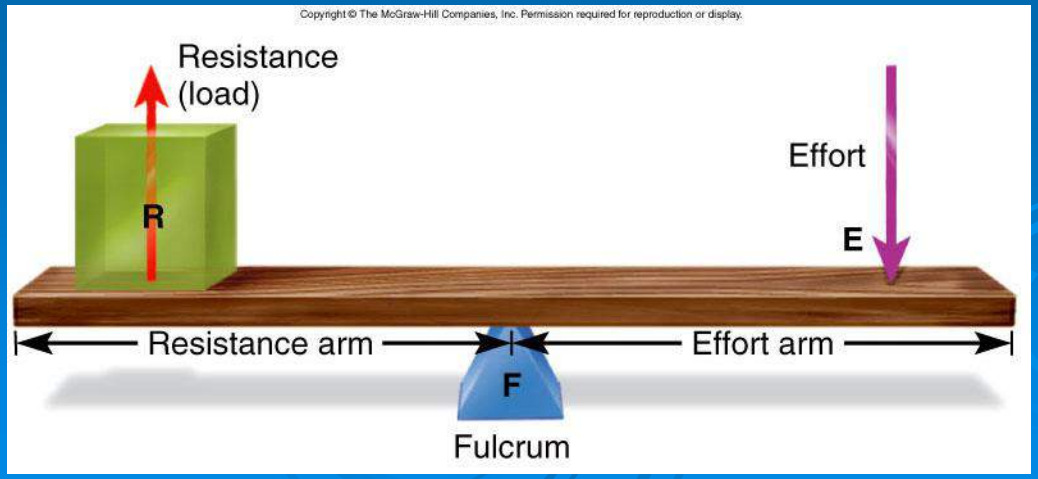
You might head a football using the pivot joint in your neck, which allows your head to rotate.

What type of joint allows a handball player's fingers to spread apart so that they can control the ball with one hand?

Answer:
The joints between the metacarpals and phalanges.

# Components of a Lever

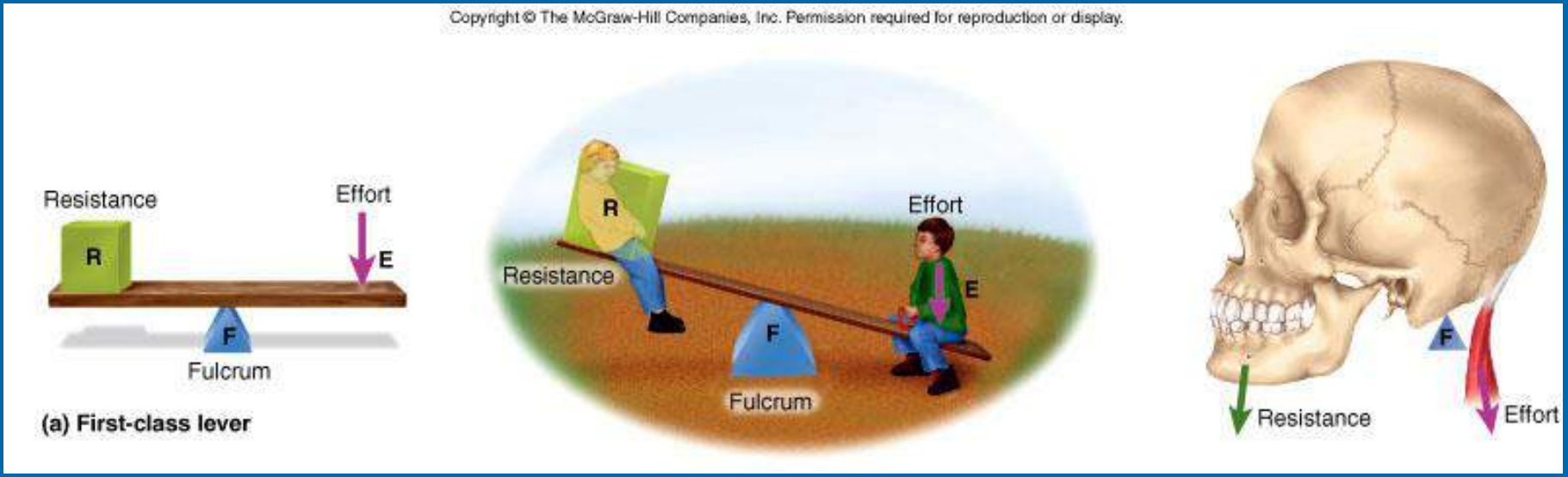
- A lever is a rigid object that rotates around a fixed point called a fulcrum
- Rotation occurs when effort overcomes resistance
  - resistance arm and effort arm are described relative to fulcrum



# Mechanical Advantage of a Lever

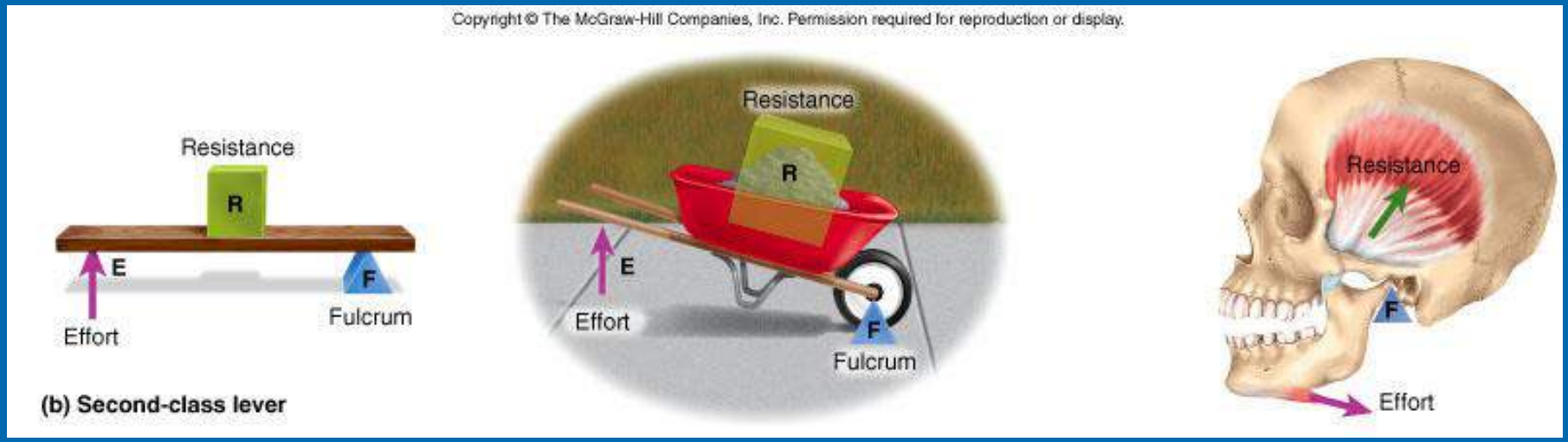
- Two effects of levers
  - lever that helps increase output of force
    - human moving a heavy object with help of crowbar
  - lever move object further and faster
    - movement of row boat with paddle
- Types of levers produce either increase in speed or force

# First-Class Lever



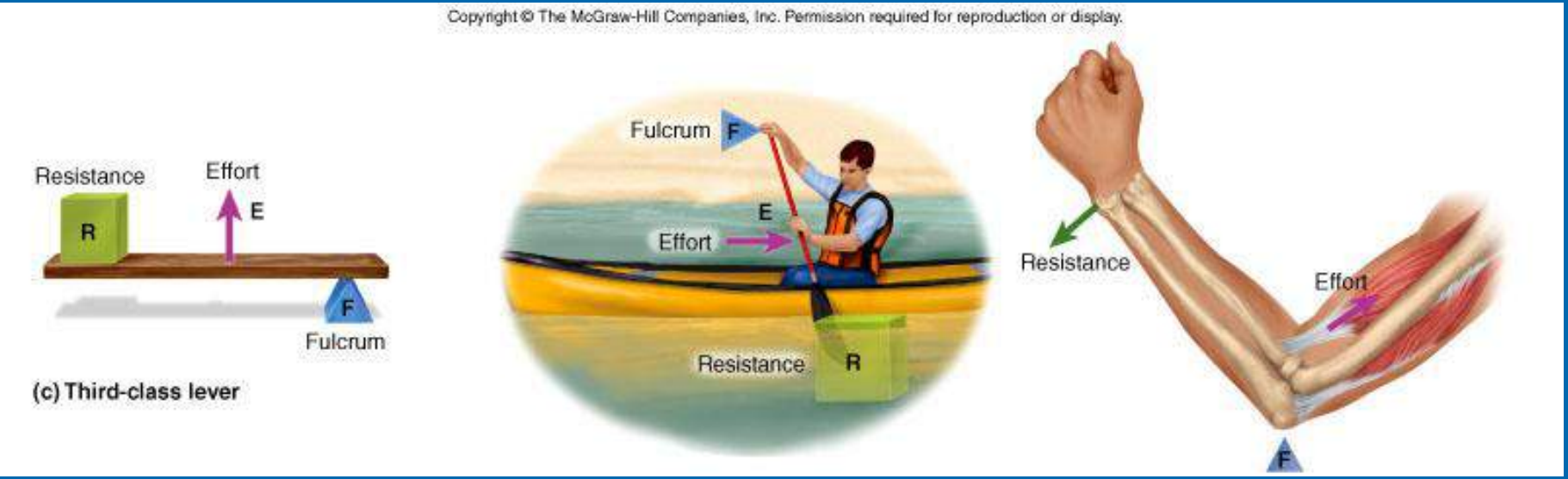

- Has fulcrum in the middle between effort and resistance
- Atlantooccipital joint lies between the muscles on the back of the neck and the weight of the face

# Second-Class Lever




- Resistance between fulcrum and effort
- Resistance from the muscle tone of the temporalis muscle lies between the jaw joint and the pull of the diagastric muscle on the chin as it opens the mouth quickly

# Third-Class Lever




- Effort between the resistance and the fulcrum
  - most joints of the body
- The effort applied by the biceps muscle is applied to the forearm between the elbow joint and the weight of the hand and the forearm

# Range of Motion

- Degrees through which a joint can move
- Determined by
  - structure of the articular surfaces
  - strength and tautness of ligaments, tendons and capsule
    - stretching of ligaments increases range of motion
  - action of the muscles and tendons
    - nervous system monitors joint position and muscle tone

# Position of joints

- Closed packed position

- Loose packed position

# Close packed position

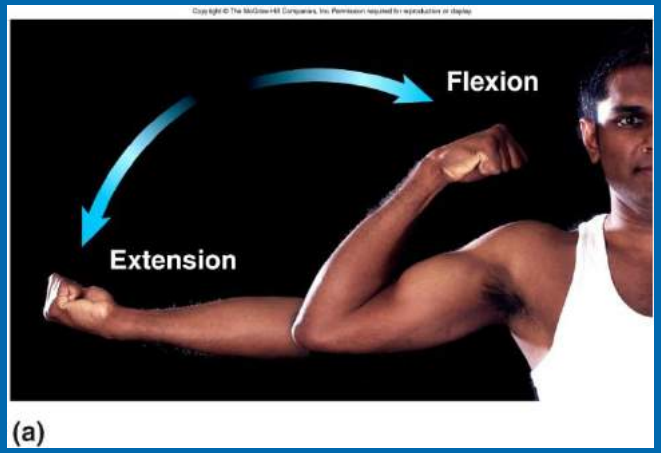
- it is the position in which the articular surfaces are fully congruent and have maximum area of contact.
- The joint is firm and rigid all the ligaments in relation to it are mostly taut.
- No dislocation but if does occur then the most damage occurs
- Eg. Shoulder joint abducted and laterally rotated, elbow fully extended.

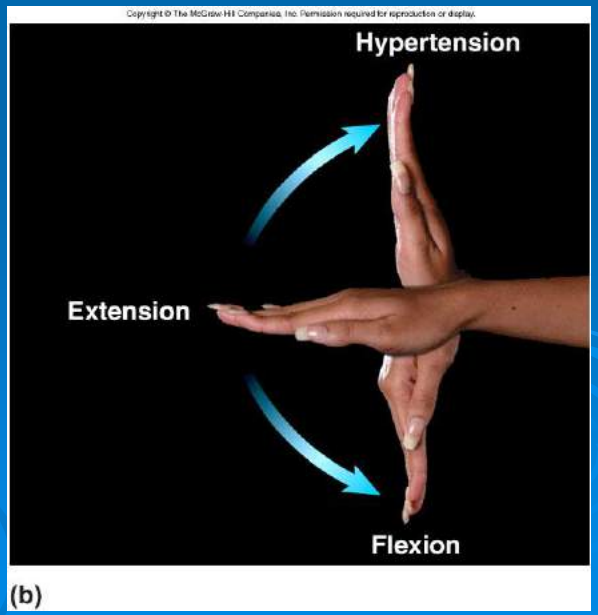
# Loose packed position

- In this the articular surfaces are incongruent.
- The joint space is freely mobile in this position and prone to disclocation.
- Eg. Shoulder joint semiabducted

# Flexion, Extension and Hyperextension

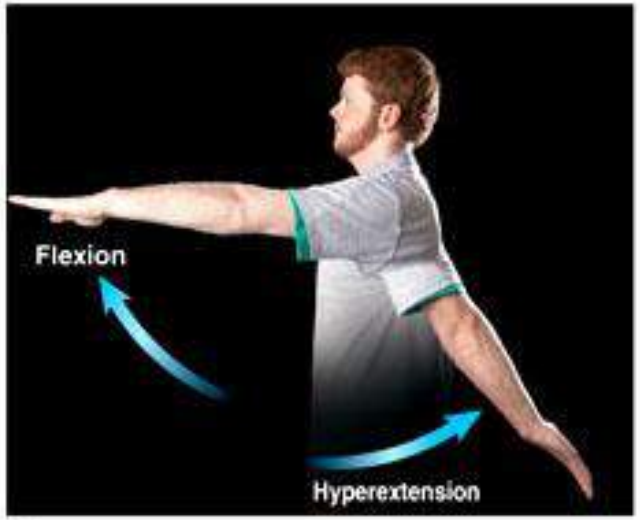
- Flexion decreases the angle of a joint
- Extension straightens and returns to the anatomical position
- Hyperextension = extension beyond 180 degrees



# Flexion, Extension and Hyperextension

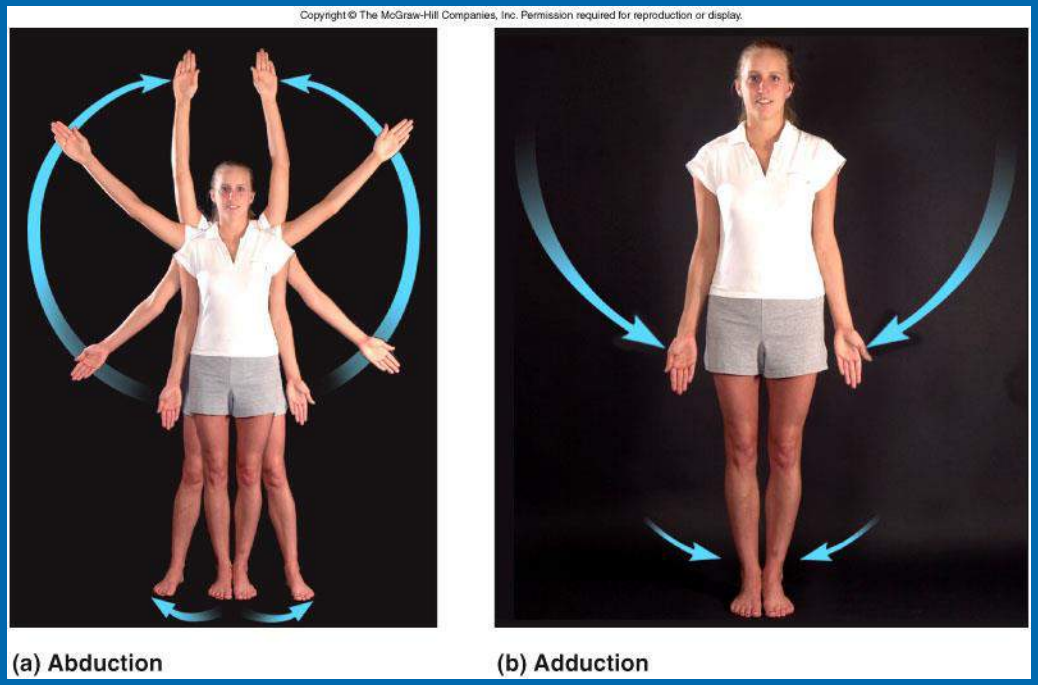





(c)

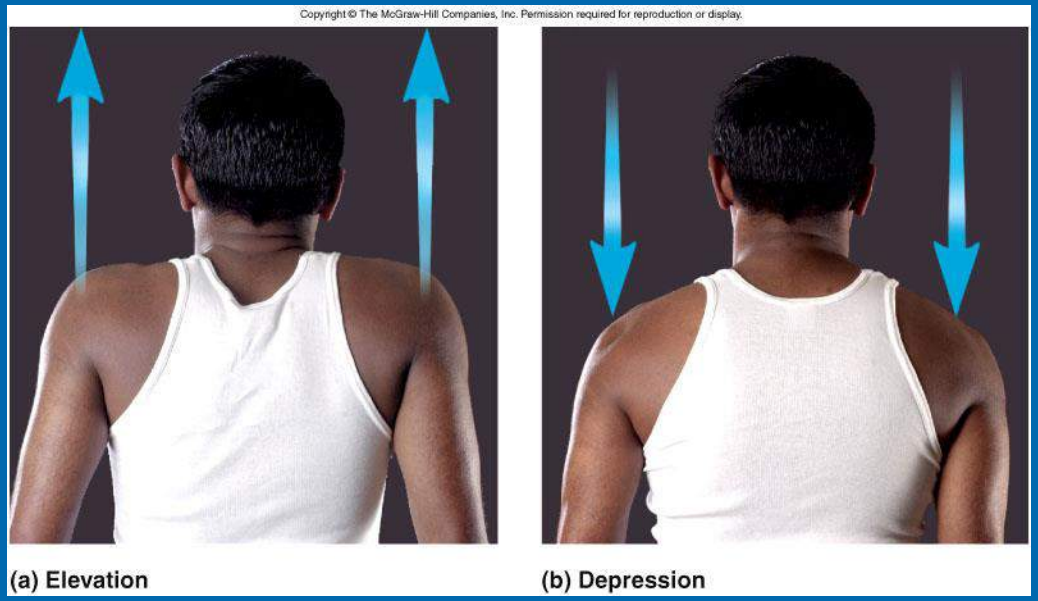

(d)

# Abduction and Adduction




- Abduction is movement of a part away from the midline
  - hyperabduction – raise arm over back or front of head
- Adduction is movement towards the midline
  - hyperadduction – crossing fingers

# Elevation and Depression




- Elevation is a movement that raises a bone vertically
  - mandibles are elevated during biting and clavicles during a shrug
- Depression is lowering the mandible or the shoulders

# Protraction and Retraction

- Protraction = movement anteriorly on horizontal plane
  - thrusting the jaw forward, shoulders or pelvis forward
- Retraction is movement posteriorly



(a) Protraction

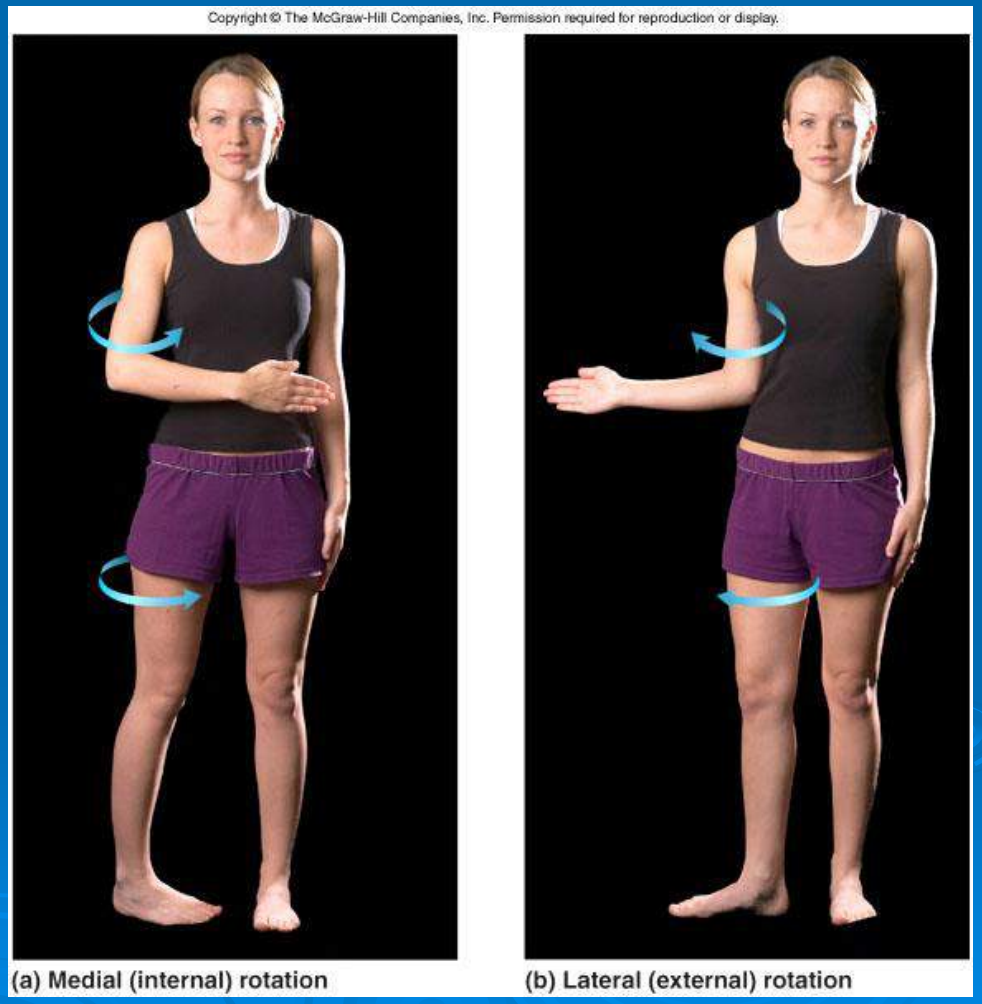
(b) Retraction

# Circumduction

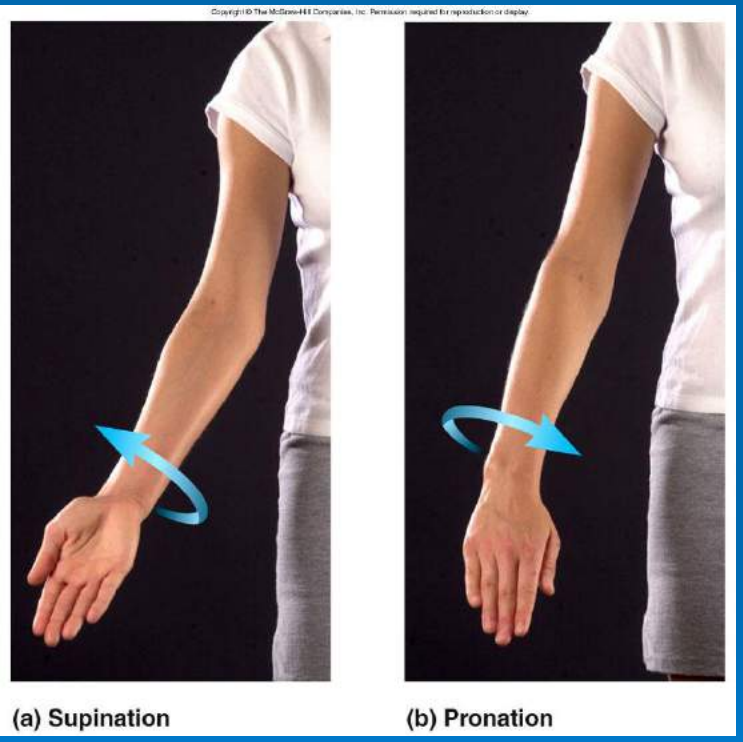
- Movement in which one end of an appendage remains stationary while the other end makes a circular motion
- Sequence of flexion, abduction, extension and adduction movements
  - baseball player winding up for a pitch

# Rotation

- Movement on longitudinal axis
  - rotation of trunk, thigh, head or arm
- Medial rotation turns the bone inwards
- Lateral rotation turns the bone outwards

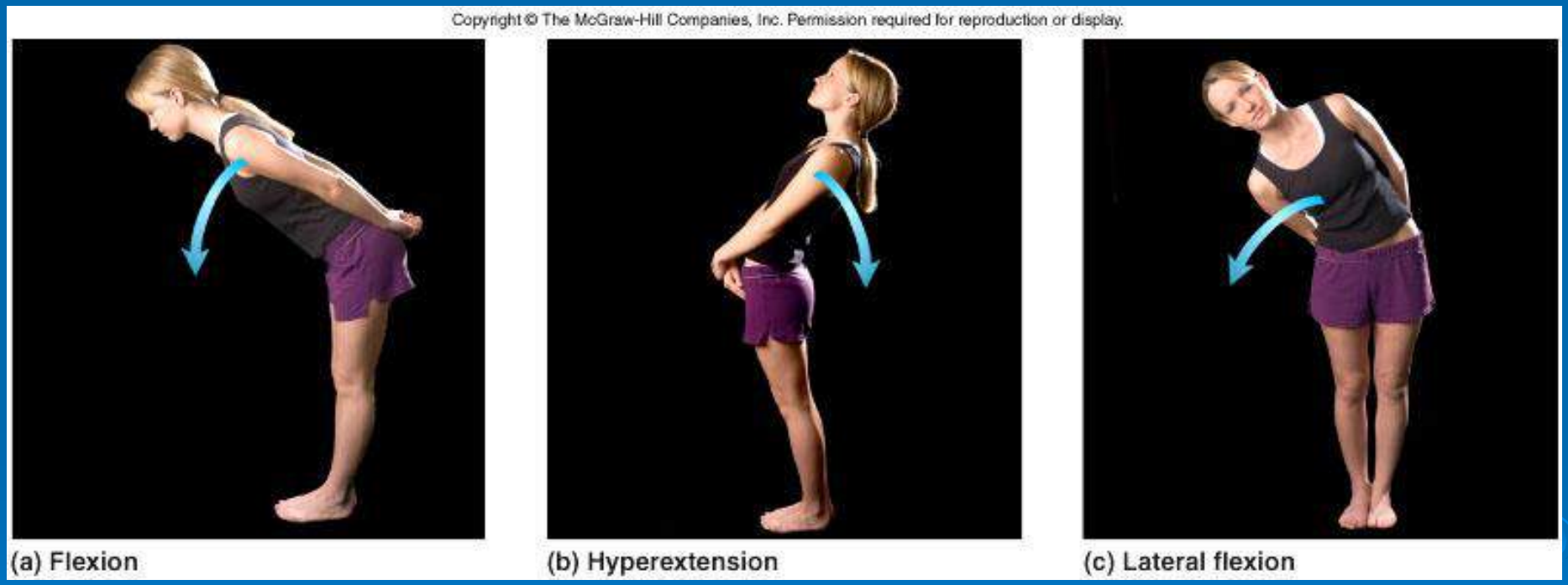


# Supination and Pronation



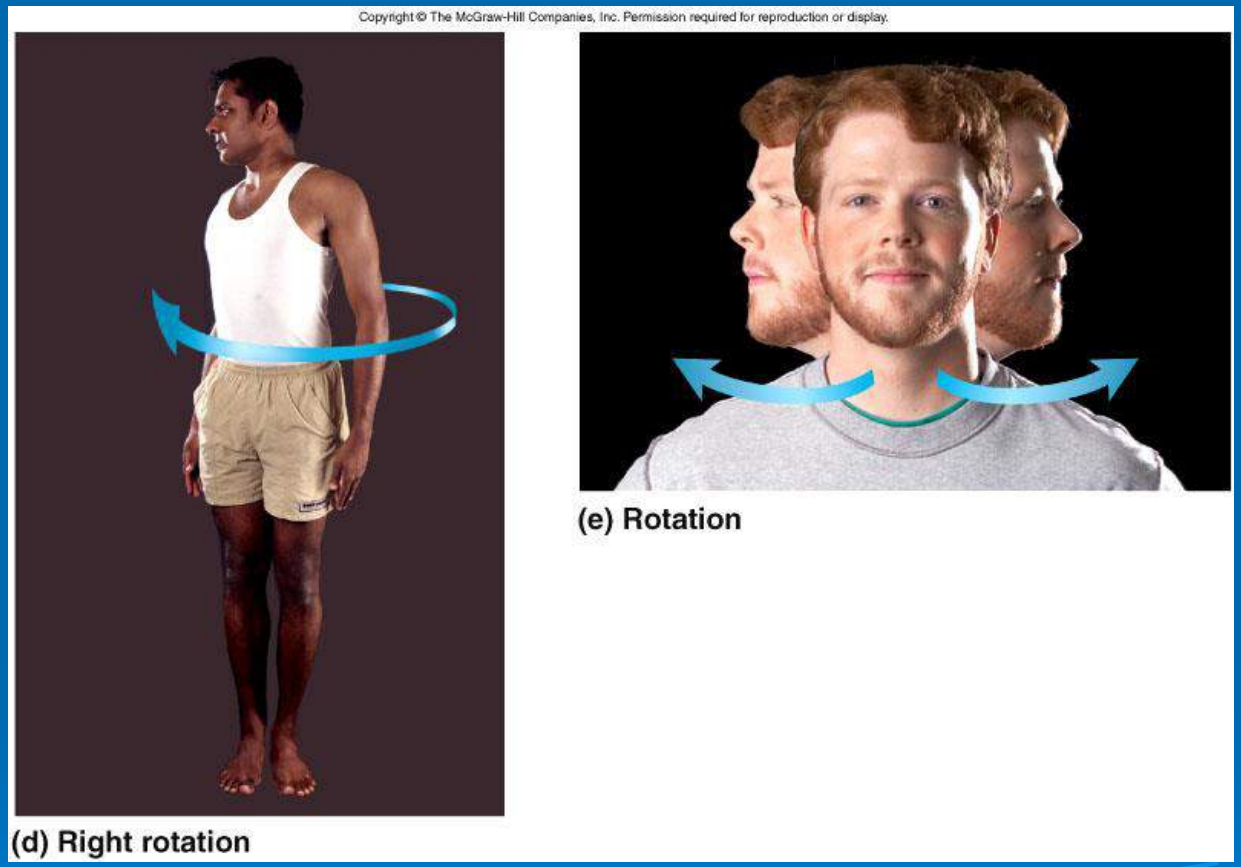

- In the forearm and foot
- Supination
  - rotation of forearm so that the palm faces forward
  - inversion and abduction of foot (raising the medial edge of the foot)
- Pronation
  - rotation of forearm so the palm faces to the rear
  - eversion and abduction of foot (raising the lateral edge of the foot)

# Movements of Head and Trunk



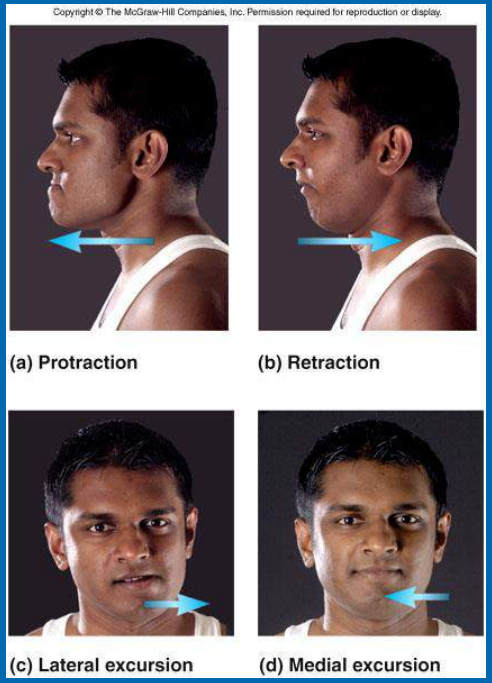

- Flexion, hyperextension and lateral flexion of vertebral column

# Rotation of Trunk and Head




- Right rotation of trunk; rotation of head

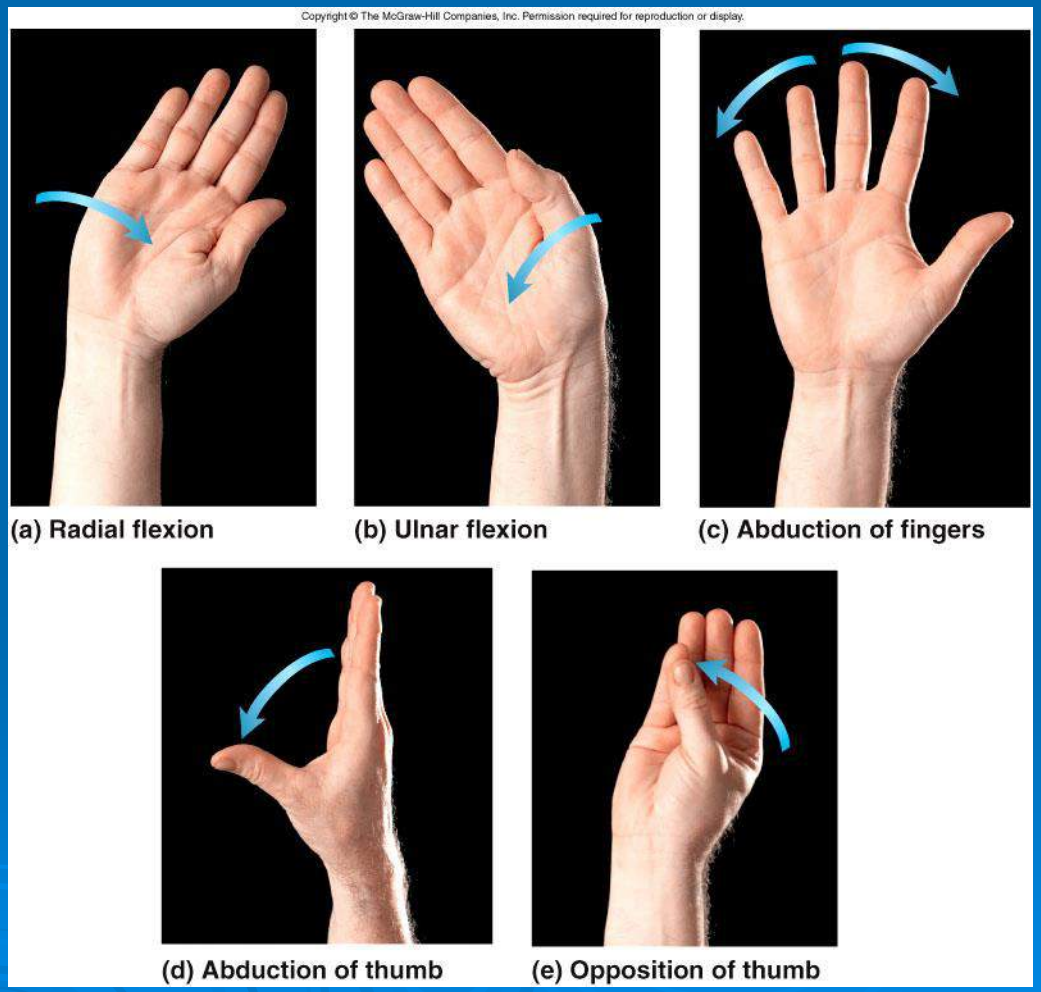
# Movements of Mandible



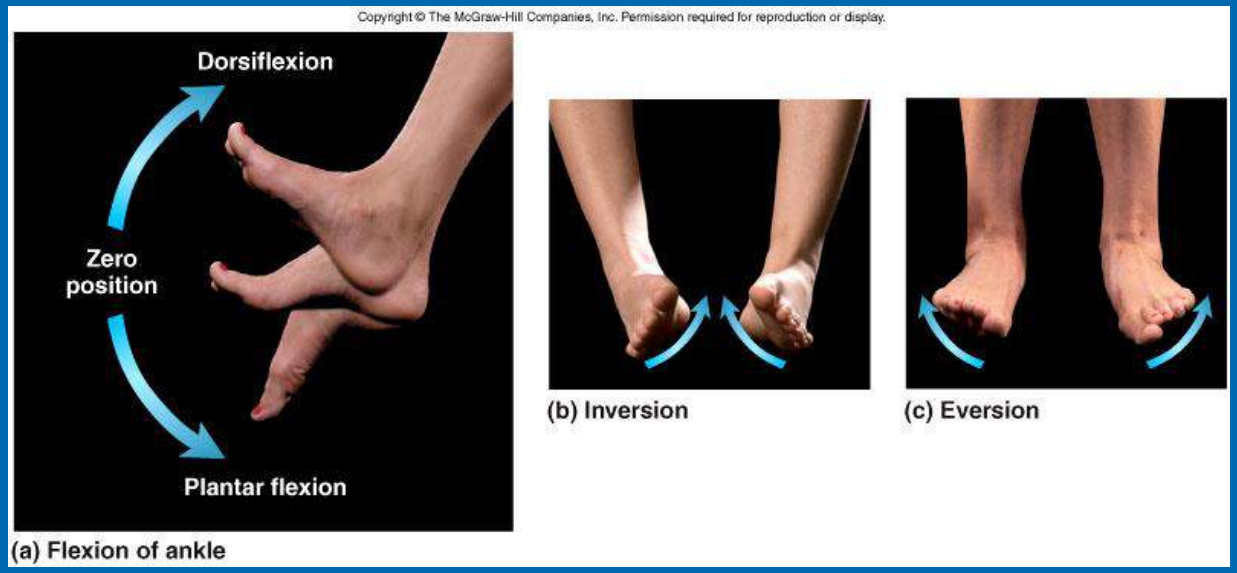

- Lateral excursion = sideways movement
- Medial excursion = movement back to the midline
  - side-to-side grinding during chewing
- Protraction – retraction of mandible

# Movement of Hand and Digits

- Radial and ulnar flexion
- Abduction of fingers and thumb
- Opposition is movement of the thumb to approach or touch the fingertips
- Reposition is movement back to the anatomical position



# Movements of the Foot

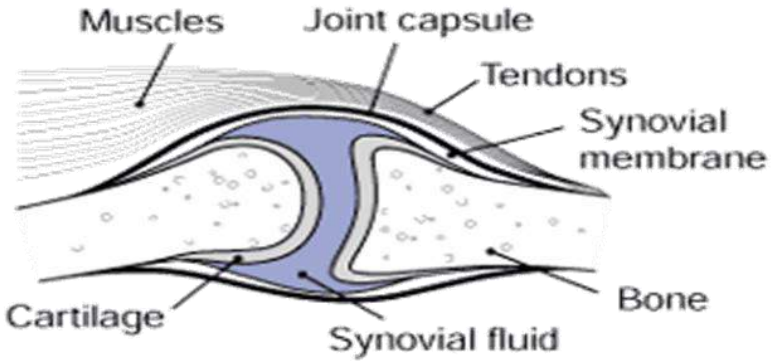



- Dorsiflexion is raising of the toes as when you swing the foot forward to take a step (heel strike)
- Plantarflexion is extension of the foot so that the toes point downward as in standing on tiptoe
- Inversion is a movement in which the soles are turned medially
- Eversion is a turning of the soles to face laterally

# Inflammatory Conditions Associated with Joints

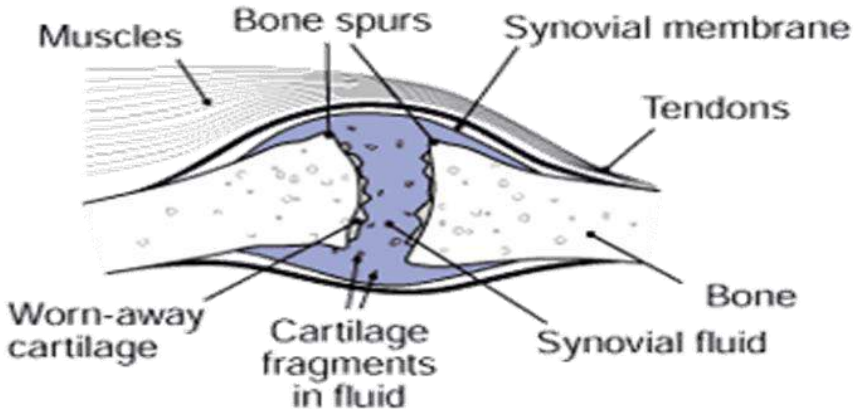
- Bursitis – inflammation of a bursa usually caused by a blow or friction
- Tendonitis – inflammation of tendon sheaths
- Arthritis – inflammatory or degenerative diseases of joints

## A Healthy Joint




In a healthy joint, the ends of bones are encased in smooth cartilage. Together, they are protected by a joint capsule lined with a synovial membrane that produces synovial fluid. The capsule and fluid protect the cartilage, muscles, and connective tissues.

## A Joint With Osteoarthritis

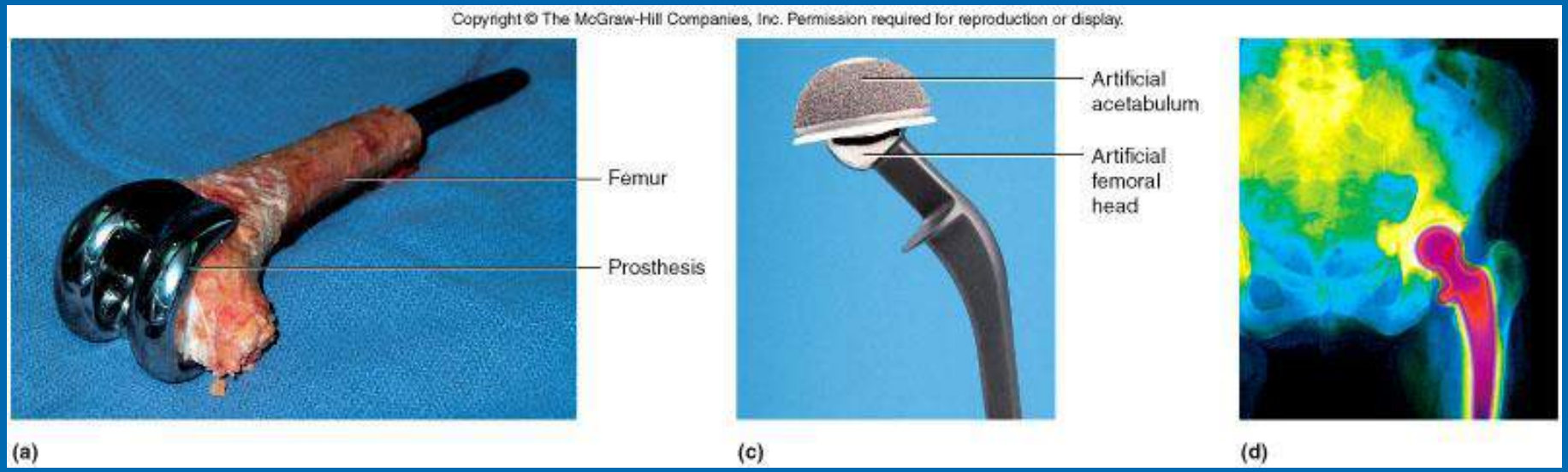



With osteoarthritis, the cartilage becomes worn away. Spurs grow out from the edge of the bone, and synovial fluid increases. Altogether, the joint feels stiff and sore.

# Rheumatoid Arthritis

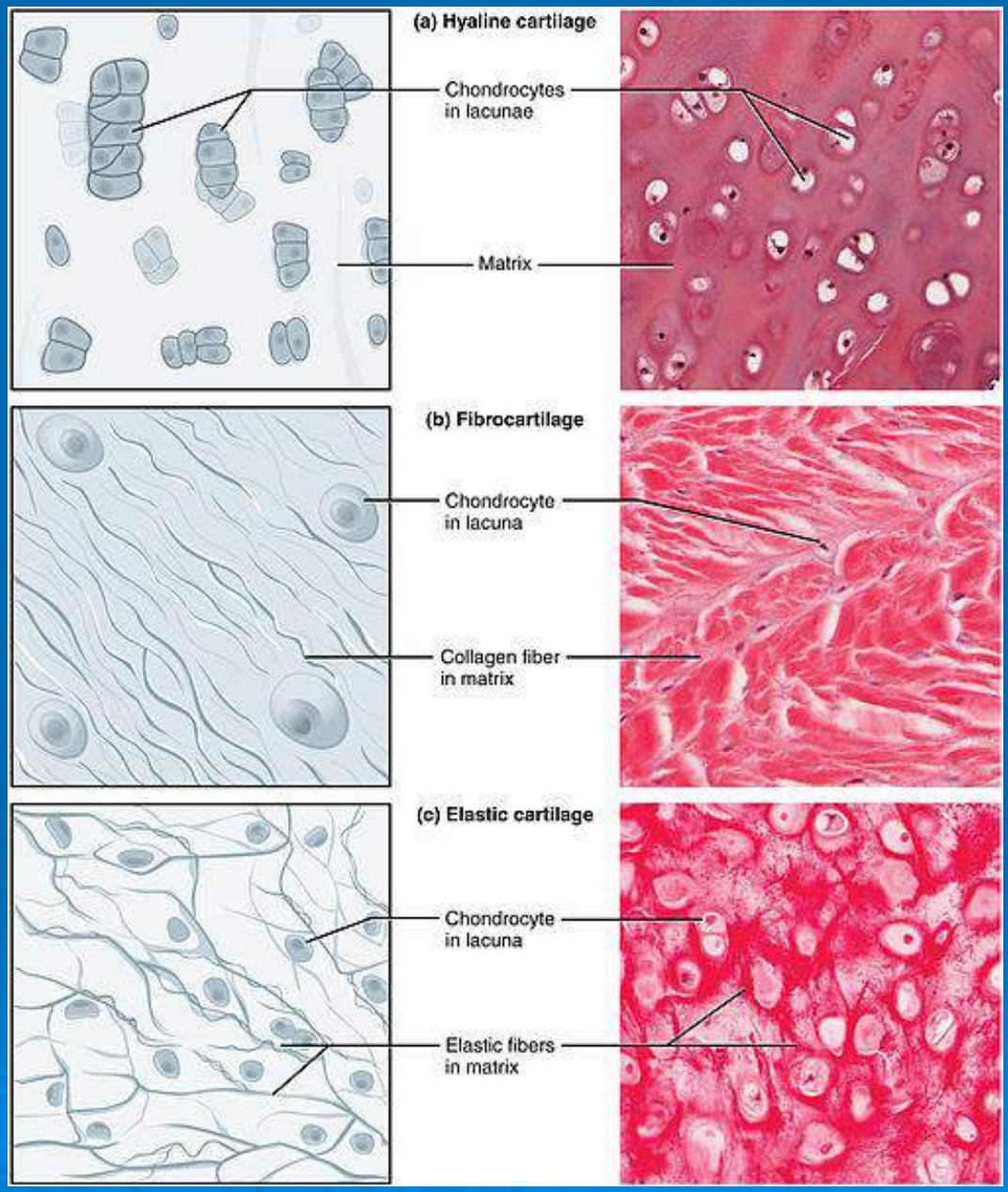
# Gouty Arthritis

# Joint Prostheses



# Types of cartilage

- Hyaline
- Fibrocartilage
- Elastic



# BONE VERSUS CARTILAGE

| BONE | CARTILAGE |
| --- | --- |
| Bone is any rigid form of connective tissue, which is composed of calcium salts and forms the skeleton of vertebrates | Cartilage is a firm, flexible connective tissue, mainly found in the larynx, respiratory tract, external ear, and articulating surface of joints |
| Strong and nonflexible connective tissue | Flexible connective tissue |
| Made up of proteins, calcium, and phosphorous | Made up of proteins and sugars |
| Consist of osteocytes | Consist of chondrocytes |
| Can not be bent | Can be bent |
| Blood vessels are present | Blood vessels are absent |
| Lacunae consist of canaliculi between osteocytes | Lacunae do not contain canaliculi between chondrocytes |
| Provide skeletal support and shape to the body | Provide flexibility to the body and smoothen bone surfaces and joints |
| Form the skeleton | Found in the ear, nose, larynx, trachea, ribs, and joints |

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